

PROJECT MANUAL



RHODE ISLAND COLLEGE

Adams Library Elevator Addition

600 Mt Pleasant Ave
Providence, RI 02908

RGB #6831
June 2024

PART 1 of 2

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions, Supplementary Conditions and applicable portions of Division 1 of the Specification are a part of this Section, which shall consist of all labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation and other facilities and services necessary for the proper execution and completion of the work, whether temporary or permanent and whether or not incorporated or to be incorporated in the work; and as related to the project or projects defined in the Bidding Requirements.
- B. The specification format used herein is in accordance with MASTERFORMAT, CSI (2004 Format) and in no way intends to restrict this Contractor from expediting his work as he sees fit, nor is there any intention of segregating the units of work as related to specific trades involving jurisdictional problems.

1.2 CONTRACTOR'S DUTIES

- A. The Contractor is responsible for all personnel involved in the work, including those of his direct employ, his sub-contractors and suppliers of materials and equipment and/or labor. The Technical Specifications have been divided for convenience only to cover the scope of work, and where reference to a particular contractor is noted, it is for convenience only. The Owner and Architect only recognize one Contractor as party to this Contract.
- B. As it is impractical to enumerate every piece of equipment, device and/or accessory required for proper operation of the indicated systems specified within their respective Sections or Divisions of the Project Manual; it is intended that all materials, systems, and/or equipment, required to insure proper operation of the equipment, device, and/or accessory, be provided as a part of the Work of this Project so the specified work or system functions, and/or performs as required by the specification. To infer the intent is otherwise, is to render the specified work or system less than required.
- C. Except as specifically noted, provide and pay for:
 - 1. Labor, materials and equipment.
 - 2. Tools, construction equipment and machinery.
 - 3. Other facilities and services necessary for proper execution and completion of the Work.
- D. Pay sales, consumer, use and similar taxes for the Work or portions thereof.
- E. Secure and pay for, as necessary for proper execution and completion of the Work, and as applicable at time of receipt of Bids:
 - 1. Permits.
 - 2. Government fees.
 - 3. Licenses.
- F. Give required notices.

- G. Comply with codes, ordinances, rules, regulations, orders and other legal requirements of public authorities which bear on the performance of the Work.
 - H. Promptly submit written notice to the Architect of observed variance of Contract Documents from legal requirements.
 - I. Lay out all work and be responsible for all lines, elevations, measurements of the building, utilities and site work executed under the Contract. Verify the figures shown before laying out the Work and be responsible for any error resulting from failure to do so. Employ a competent registered engineer or registered land surveyor, approved by the Architect, for establishing all lines, levels and dimensions, and place at the disposal of the Architect, as required for checking purposes.
 - J. Enforce strict discipline and good order among employees. Do not employ persons not skilled in assigned task.
 - K. Notify all trades, sub-contractors and suppliers of all designated alternatives and be responsible for their coordination.
 - L. At your option, certain indicated materials and/or procedures are specified herein to be used in lieu of other indicated materials and/or procedures, at no change in Contract Price. Such options should be analyzed and coordinated during the bidding period, so that the selection of any may immediately be brought to the Architect's attention, once the Contract is awarded (within thirty days thereafter).
- 1.3 SCOPE OF THE WORK: Includes but is not limited to:
- A. EXTERIOR:
 - 1. **[Exterior scope of work].**
 - B. INTERIOR:
 - 1. **[Interior scope of work].**
- 1.4 SPECIAL CONDITIONS
- A. The Contractor must schedule the Work, in the various rooms with the Owner, a minimum of seven days in advance.
 - B. The Owner will make available to the Contractor requested spaces, to be determined during the course of the Work. Upon substantial completion of the work in these areas and a minimal punch list, the Owner will make additional spaces available to the Contractor. Punch list completion must be scheduled to permit notification of tenants.
 - C. Miscellaneous work in other areas of the building must be scheduled seven (7) days in advance and approved by the Owner.
 - D. The Contractor is responsible to physically isolate all work areas, to protect residents, while maintaining safe egress.
 - E. The Contractor shall maintain a professional relationship with all tenants, employees and other occupants. All incidents with the residents must be promptly reported to the Owner or the

Owner's Representative. The Owner will resolve all issues with all employees and other occupants.

F. Use of premises:

1. No storage of materials in the building. (Locate trailer in area designated by the Owner, and repair all damaged areas upon completion of the work.)
2. Provide office trailer and toilet facilities for work force. Do not use building facilities.
3. No smoking on the site or within the buildings.
4. Daily clean-up required.
5. Use of on-site utilities, electric and water permitted. Do not overtax existing systems.
6. Major movement of materials must be scheduled so as to minimize inconvenience of the tenants. Coordinate with the Owner.
7. Notify the Owner of utility interruptions a minimum of thirty-six (36) hours in advance.

1.5 HEALTH AND SAFETY PRECAUTIONS

A. HAZARDOUS BUILDING MATERIALS:

1. Prior to commencing any removal or demolition operations, coordinate with the Owner/Operator to ensure that an asbestos survey has been conducted, in accordance with National Emission Standard for Hazardous Air Pollutants (NESHAP), 40 CFR, Part M, Section 61.145, of the Clean Air Act.
2. Notify the EPA prior to demolition/renovation operations in which more than 260 L.F. or 160 S.F. of regulated asbestos-containing material (RACM) is to be stripped or removed from facility components.
3. If during the course of the Work hazardous materials are encountered, or suspicion exists that such may be prevalent, including, but not limited to asbestos and/or lead paint, immediately and prior to any removal, contact the governing agency for testing and removal procedures.

B. OSHA:

1. These construction documents, and the joint and several phases of construction hereby contemplated, are to be governed, at all times, by the applicable portions of the Federal Laws, including but not limited to, the latest amendments of the following:
 - a. Williams-Steiger Occupational Safety and Health Act of 1970, Public Law 91-956;
 - b. Part 1910 - Occupational Safety and Health Standards, Title 29, Code of Federal Regulations, as amended to date;
 - c. Part 1926 - Safety and Health Regulations for Construction, Title 29, Code of Federal Regulations, as amended to date.
2. This Project, the Contractor and his sub-contractors shall, at all times, be governed by applicable Chapters of Title 29, Code of Federal Regulations, Part 1926 - Safety and Health Regulations for Construction, as amended to date.
 - a. Note: Furnish the Owner and Architect copies of all accident reports.

C. Dig Safe:

1. All excavations near underground public utility facilities shall be performed in accordance with Connecticut State Law.

D. Emergencies:

1. Should tornado, hurricane, gale or heavy wind warnings be issued, take precautions to minimize the danger to persons, to the work, and to the adjacent property. Damage caused to any part of the work shall be rectified or replaced to the complete satisfaction of the Architect and at no expense to the Owner. Injury to personnel or damage to adjacent property because of the work shall be the complete responsibility of the Contractor, and he accepts exclusive responsibility for same.

E. Loading:

1. Do not load any part of the work involved in this Contract, during construction, with a load greater than it is calculated to carry with safety. Should any accidents or damage occur through any violation of this requirement, the Contractor shall be held responsible under his Contract and Bond. When, in the opinion of the Architect, portions of the structure appear to be overloaded, it shall be the Contractor's responsibility to prove otherwise, or the Contractor shall follow the instructions of the Architect in connection with reduction of the loads.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain at job site, one copy of:

1. Contract Drawings.
2. Specifications.
3. Addenda.
4. Reviewed Shop Drawings.
5. Record Drawings.
6. Change Orders.
7. Other modifications to Contract.
8. Field Test Reports.
9. Approved materials, samples and colors.

B. Store documents in approved field construction office, apart from documents used for construction.

1. Provide files and racks for storage of documents.
2. File documents in accordance with Project Filing Format of MASTERFORMAT.
3. Maintain documents in clean, dry, legible condition.
4. Do not use record documents for construction purposes.
5. Make documents available at all times for inspection by Architect and Owner.

C. Recording changes:

1. Provide red pen or pencil for all marking.
2. Keep record documents current.
3. Do not permanently conceal any work until required information has been recorded.
4. Contract Drawings: Legibly mark to record actual construction and the following:
 - a. Record various elements of foundations in relation to lowest floor elevation.
 - b. Reference horizontal and vertical location of underground utilities and appurtenances to permanent surface improvements.
 - c. Reference location of internal utilities and appurtenances concealed in construction to visible and accessible features of structure.

- d. Record field changes of dimensions and details.
 - e. Record changes made by Change Order or Field Order.
 - f. Record details not on original Contract Drawings.
5. Specifications and Addenda: Legibly mark up each Section to record the following:
- a. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
 - b. Changes made by Change Order and Field Order.
 - c. Other matters and materials not previously specified.
6. Shop Drawings: Maintain as record documents; legibly annotate drawings to record changes after review.
- 1.7 TRANSPORTATION AND HANDLING
- A. Transport all materials and equipment on legally approved conveyances as required or recommended by the respective manufacturer or supplier.
 - B. Receive and handle all materials and equipment, at the project site, by conveyances or methods as recommended by the respective manufacturer or supplier.
 - C. Coordinate delivery of equipment and materials when two or more trades, contractors or suppliers are involved.
 - D. Remove from the site any material or item of equipment damaged during the transportation or handling process, and immediately replace at no additional cost to the Owner.
- 1.8 STORAGE AND PROTECTION
- A. Store all materials and equipment as recommended by the respective manufacturer or supplier, including the following minimum requirements.
 - B. Upon receipt of such materials and equipment, check, distribute, store and safeguard in a clean, dry, ventilated location.
 - C. Elevate off the ground, items which can be stored in exterior locations, and completely cover with approved tarpaulins. Protect against the elements at all times.
 - D. Maintain all storage areas in a clean and orderly condition at all times.
 - E. Immediately replace any material or item of equipment damaged, due to inadequate storage protection, at no additional cost to the Owner.
- 1.9 CUTTING AND PATCHING
- A. Execute cutting, including excavating, fitting or patching work required to:
 - B. Make several parts fit properly.
 - C. Uncover work to provide for installation of ill-timed work.

- D. Remove and replace defective work.
- E. Remove and replace work not conforming to the Contract Documents.
- F. Remove samples of installed work, as specified, for testing.
- G. Install specified work in existing construction.
 - 1. In addition to the Contract requirements, upon written instructions from Architect:
 - a. Uncover work to provide for Architect's observation of covered work, as required by General Conditions.
 - b. Remove samples of installed materials for testing; as required by the General Conditions.
 - 2. Do not endanger any work by cutting or altering work, or any part of it.
 - 3. Do not cut or alter work of another Contractor without written permission of the Architect.
 - 4. Prior to cutting which affects structural safety of Project, or work of another Contractor, submit written notice to Architect requesting consent to proceed with cutting.
 - 5. Prior to cutting and patching, done on instruction of the Architect, submit cost estimate.
 - 6. Should conditions of work, or schedule, indicate change of materials or methods, submit written recommendations to the Architect including:
 - a. Conditions indicating change.
 - b. Recommendations for alternative materials or methods.
 - c. Submittals required for Substitutions.
- H. Submit written notice, to the Architect, designating time work will be uncovered, to provide for observation.
- I. Payment for costs caused by ill-timed or defective work, or work not conforming to the Contract Documents, including costs for additional services of Architect will be borne by the Contractor.
- J. Contractor Inspection:
 - 1. Inspect existing conditions of work, including elements subject to movement or damage during:
 - a. Cutting and patching.
 - b. Excavating and backfilling.
 - 2. After uncovering work, inspect conditions affecting installation of new products.
- K. Preparation: (prior to cutting)
 - 1. Provide shoring, bracing and support as required to maintain structural integrity of the Project.
 - 2. Provide protection for other portions of the Project.
 - 3. Provide protection from the elements.
- L. Performance: Perform all work of fitting, adjustment, cutting, patching, finishing, and restoration to perfectly match the quality as specified throughout these specifications.

1.10 CONNECTING TO AND USE OF EXISTING

- A. Demolish and remove from site all existing construction work as indicated. Do such work in a neat and orderly manner so as not to endanger the lives of the working force nor cause damage to adjacent surfaces indicated to remain.
- B. Remove portions of existing work as indicated or required, and perfectly patch, match and tie into the new work.
- C. Repair existing walls, floors, ceilings, partitions, doors, frames, etc., where required for tying into, including existing systems such as electrical or mechanical, etc.
- D. If existing conditions, indicated to remain, include defective work, deteriorated or rotted materials, immediately notify the Architect. Do not conceal such materials.
- E. Relocate and remove certain existing items, facilities and equipment, as indicated. Items designated to be removed, and not be re-used, shall remain the property of the Owner and placed on the site where directed by the Owner.
- F. Quality of Work/Responsibility to Match Existing:
 - 1. Perfectly match the existing building finishes for all new work, unless otherwise specified or shown. Such matching includes quality, style, character, finish and color. Likewise, repair or replace, in exact likeness to the existing, any existing surfaces, materials, fixtures, or items damaged by the process of completing the new work.

1.11 CONTRACTOR USE OF PREMISES

- A. Confine operations at site to areas permitted by:
 - 1. Law.
 - 2. Ordinances.
 - 3. Permits.
 - 4. Contract Documents.
- B. Do not unreasonably encumber the site with materials and equipment.
- C. Do not load structure with weight that will endanger structure.
- D. Assume full responsibility for protection and safekeeping of products stored on the premises.
- E. Move any stored products which interfere with operations of Owner or other Contractor.
- F. Obtain and pay for use of additional storage or work areas needed for operations.
- G. Limit use of site for work and storage within confines of the Project Limit Line.

1.12 PARTIAL OWNER OCCUPANCY

- A. Schedule early completion of designated areas for Owner's usage prior to Substantial Completion of the entire Project.
- B. Contractor provide:

1. Access for Owner personnel.
2. Operation of mechanical and electrical systems.

C. Prior to occupancy, execute Certificate of Substantial Completion for designated areas.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 00 50

SECTION 01 02 00 - CONTRACT – LIST OF DRAWINGS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

- A. See Modified AIA Document A201.

1.2 SPECIFICATIONS

- A. Titles to Divisions and paragraphs in these specifications and in the notes on the drawings are introduced for convenience, and shall not be taken as an exact, correct or complete segregation of materials and labor.
- B. No responsibility is assumed by the Architect and Owner for omissions or duplications by the Contractor or his subcontractors due to real or alleged error in arrangement of matter in this specification or in notes on the drawings.
- C. Latest revisions of Federal, State and ASTM Specifications shall be used where only the specification number without date or revision number is given in specifications.
- D. The omissions from the plans and/or specification of express reference to any labor, equipment, system, assembly to make such system/assembly operational or materials reasonably to be inferred therefrom and necessary for the proper execution of the work shall not relieve the Contractor or Subcontractor from furnishing them of a kind in keeping with the general character of the work.

1.3 DRAWINGS

- A. List of Drawings:

GENERAL

G000	COVER
G001	ABBREVIATIONS AND SYMBOLS

ARCHITECTURAL

A010	CODE REVIEW
A011	CODE REVIEW
A030	CONSTRUCTION TYPES & UL PENETRATIONS
D101	DEMOLITION PLANS
A101	PROPOSED PLANS
A201	DEMO & PROPOSED EXTERIOR ELEVATIONS
A202	PROPOSED EXTERIOR ELEVATIONS
A401	BUILDING SECTION
A500	EXTERIOR & ROOF DETAILS
A501	TERMINATION & DETAILS

A601 REFLECTED CEILING PLANS
A701 INTERIOR ELEVATIONS
A801 ELEVATOR DETAILS
A910 DOOR & WINDOW SCHEDULE

STRUCTURAL

S100 STRUCTURAL DETAILS AND NOTES
S101 STRUCTURAL PLANS
S201 STRUCTURAL DETAILS

FIRE PROTECTION

FP000 FIRE PROTECTION LEGEND & ABBREVIATIONS
FP201 FIRE PROTECTION NEW WORK

MECHANICAL

M000 MECHANICAL LEGEND & ABBREVIATIONS
M200 MECHANICAL PLANS
M600 MECHANICAL DETAILS
M700 MECHANICAL SCHEDULES

ELECTRICAL

E000 ELECTRICAL LEGEND & ABBREVIATIONS
E200 ELECTRICAL LIGHTING PLANS
E300 ELECTRICAL POWER & SYSTEM PLAN
E301 ELECTRICAL POWER & SYSTEM PLAN – MAIN ELECTRIC ROOM
E400 ELECTRICAL FIRE ALARM PLAN
E500 ELECTRICAL ONE LINE RISER DIAGRAM & SCHEDULES
E600 ELECTRICAL DETAILS

END OF SECTION 01 02 00

01 10 00 – SUMMARY**PART 1 - GENERAL****1.1 PROJECT**

- A. The Project consists of the construction of the following types of work:
 - 1. New fully accessible elevator lobby and shaft addition to the west of the existing facility. This includes but is not limited to site exaction, shoring, new roof to existing roof tie-in, minor siding removal, and saw cut openings.

1.2 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 00 50 00 – Contracting Forms.

1.3 DESCRIPTION OF WORK

- A. Scope of demolition and removal work is shown on drawings plus as specified in Section 020600
- B. Scope of alterations work is shown on drawings and/or as specified herein.
- C. Site modifications: None
- D. Architectural modifications: Additional Gutters

1.4 SCHEDULE

- A. The date of commencement of the Work shall be the latter of: (i) the issuance of the Purchase Order by the Owner; and (ii) the date set forth in a notice to proceed issued by the User Agency.
- B. Ordering of products, Building Permit, coordination and preparatory work shall commence immediately upon receipt of Purchase Order.
- C. Construction at the site can commence immediately upon receipt of PO and building permit and shall be agreed upon with the User Agency.
- D. The substantial completion date is June 15th,2025. This is the date to which liquidated damages may apply and may only be adjusted as provided for in the Contract Documents. Contractor shall be responsible for completing the submittals required for issue of a Purchase Order in a timely manner. No extension will be granted for purchasing delays. Contractor shall account for any premium time required to meet the substantial completion date of June 15th,2025 in their base bid.
- E. Final Completion is July 15th,2025. This date represents the completion of all outstanding punchlist items and complete demobilization of the site.
- F. Cooperate with User Agency to minimize conflict and to facilitate the facility's operations.

1.5 ITEMS TO BE SALVAGED

NO ITEMS REMOVED AND NOT IDENTIFIED FOR REINSTALLATION SHALL BE SLAVAGED

1.6 SUBCONTRACTOR CERTIFICATION REQUIREMENTS

- A. Installation certification from the roof manufacturer for the roofing subcontractor for both the asphalt shingle roofing and membrane roofing. Refer to roofing specification section for clarification specifics.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 10 00 – SUMMARY**PART 1 - GENERAL****1.1 PROJECT**

- A. The Project consists of the construction of the following types of work:
 - 1. New fully accessible elevator lobby and shaft addition to the west of the existing facility. This includes but is not limited to site exaction, shoring, new roof to existing roof tie-in, minor siding removal, and saw cut openings.

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- A. Scope of demolition and removal work is shown on drawings plus as specified in Section 020600
- B. Scope of alterations work is shown on drawings and/or as specified herein.
- C. Site modifications: None
- D. Architectural modifications: Additional Gutters

1.4 SCHEDULE

- A. The date of commencement of the Work shall be the latter of: (i) the issuance of the Purchase Order by the Owner; and (ii) the date set forth in a notice to proceed issued by the User Agency.
- B. Ordering of products, Building Permit, coordination and preparatory work shall commence immediately upon receipt of Purchase Order.
- C. Construction at the site can commence 30 days from issuance of Purchase Order and shall be agreed upon with the User Agency.
- D. The substantial completion date is August 15th,2025. This is the date to which liquidated damages may apply and may only be adjusted as provided for in the Contract Documents. Contractor shall be responsible for completing the submittals required for issue of a Purchase Order in a timely manner. No extension will be granted for purchasing delays. Contractor shall account for any premium time required to meet the substantial completion date of August 15th,2025 in their base bid.
- E. Final Completion is 30 Calendar Days from Issuance of the Purchase Order. This date represents the completion of all outstanding punchlist items and complete demobilization of the site.
- F. Cooperate with User Agency to minimize conflict and to facilitate the facility's operations.

1.5 ITEMS TO BE SALVAGED

NO ITEMS REMOVED AND NOT IDENTIFIED FOR REINSTALLATION SHALL BE SLAVAGED

1.6 SUBCONTRACTOR CERTIFICATION REQUIREMENTS

- A. Installation certification from the roof manufacturer for the roofing subcontractor for both the asphalt shingle roofing and membrane roofing. Refer to roofing specification section for clarification specifics.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 14 00 – COORDINATION OF WORK WITH USER AGENCY**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Contractor Use of Site and Premises.
- B. Utility and Building Services Outages and Shutdowns.
- C. Construction Requirements in Occupied Buildings.
- D. Construction Activities in Occupied Spaces.
- E. Time Restrictions and Working Hours.
- F. Schedule Coordination.

1.2 CONTRACTOR USE OF SITE AND PREMISES

- A. User Agency intends to continuously occupy the facility. Work areas will be made available as mutually agreed to during project scheduling.
- B. Construction Operations: Limited to areas noted on Drawings. Coordinate with Site Utilization Requirements. Include in the Base Bid all costs of this coordination, including all premium time wages that may be required to meet these requirements and project schedule. Cost of all work done during second or third shifts or on weekends and holidays shall be included in the bid price. Contractor is responsible for protection and restoration of existing conditions including, but not limited to hardscape, landscape and lawns.
- C. Arrange use of site and premises to allow:
 - 1. Adjacent projects to progress as planned for the User Agency.
 - 2. Use of street and adjacent properties by the Public.
 - 3. Continued operation of the facility.
- D. For activities requiring closure of parking lots, roadways and/or walkways, seven (7) days' notice is required. Refer to Section 01 50 00 Temporary Facilities and Controls for further information.
- E. Provide access to and from site as required by law and by User Agency:
 - 1. Maintain appropriate egress for workforce and users of the facility.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit. Provide necessary signage and barriers to direct pedestrians around work areas.
 - 3. Barriers and signage must be provided by the contractor to the satisfaction of the User Agency to separate the work area from occupied areas. Efforts must be taken to limit dust, noise and odors from escaping the work area. Proper separation and protection of interior spaces shall be established and maintained during the project, to the satisfaction of the User Agency.
 - 4. Contractor is responsible for cleaning construction dust and/or debris from public areas and daily or at the request of the User Agency. Work areas within the building shall be kept tidy at all times.

5. Contractor shall provide and maintain walk-off mats at all entrances to the work site from occupied areas.

1.3 UTILITY AND BUILDING SERVICES OUTAGES AND SHUTDOWN:

- A. Prevent accidental disruption of utility services to other facilities. Contractor is responsible for restoration and damages resulting from unplanned disruptions to utilities.
- B. For life safety systems interruptions or shutdowns, including but not limited to fire sprinklers and fire alarm system, seven (7) days' written notice to User Agency and authorities having jurisdiction shall be provided. Contractor to utilize Fire Sprinkler and Alarm System Impairment Notification Forms found in Section 00 73 02. Contractor is responsible for providing Fire Alarm Technician or support personal to provide the necessary bypassing or fire watch as required for fire sprinkler or other life safety shutdowns.
- C. Electrical, plumbing, network and other utility shutdowns shall be scheduled off hours. Contractor shall provide written request for utility shutdown at least 72 hours in advance.
- D. When construction activities impact ventilation, heating or air conditioning to occupied building spaces, the contractor shall provide the necessary equipment to maintain proper ventilation rates and a temperature of 68° heating and 72° cooling. Prior to the decommissioning of equipment, the contractor shall submit a plan for temporary HVAC services, including unit location, utility connection, ductwork tie in and other logistical considerations.

1.4 CONSTRUCTION REQUIREMENTS FOR OCCUPIED BUILDINGS:

- A. User Agency intends to continuously occupy the facility. Work areas will be made available as mutually agreed to during project scheduling.
- B. The building and surrounding areas will be occupied during construction. The Contractor shall be solely responsible for initiating, maintaining and supervising safety, security and protection programs and shall comply with all applicable laws, ordinances, rules and regulations concerning safety of people and the protection of property.
- C. Barriers and signage must be provided by the contractor to the satisfaction of the User Agency to separate the work area from occupied areas. Appropriate signage, approved by the User Agency, shall be placed at all potential entrances to the Project Site and maintained throughout the project.
- D. Efforts must be taken to limit dust, noise and odors from escaping the work area. Proper separation and protection of interior spaces shall be established and maintained during the project, to the satisfaction of the User Agency. Contractor shall provide and maintain walk-off mats and plastic barriers at work site entries.
- E. Contractor shall provide appropriate masking of building supply air intakes to protect indoor air quality and limit transfer of odors. Contractor to coordinate with User Agency regarding shut down of appropriate units as work continues.
- F. Contractor to provide air scrubbing and/or negative air machines to prevent odors from escaping the Project Site.
- G. During the progress of the Work, the Contractor shall so conduct his work that as little inconvenience as possible is caused to the occupants. At the close of the work each day, the Contractor shall pick up and stow all equipment and miscellaneous material leaving the site in a neat and safe condition.

- H. The Contractor shall repair or replace, at his own expense, with new any item, surface, or object that is damaged by the Contractor or damaged because of the Contractor's actions during the course of the Work and during any guarantee period.
- I. Site and building conditions shall be restored to their condition as they were at the start of the Work. Before commencing work, the Contractor shall report any existing damage to the Architect in writing to assure that the Contractor will not be liable for preexisting damage.
- J. Contractor is responsible for cleaning construction dust and/or debris from public areas and daily or at the request of the User Agency. Work areas within the building shall be kept tidy at all times.
- K. Refer to Section 01 50 00 – TEMPORARY FACILITIES AND CONTROLS for more information.

1.5 CONSTRUCTION ACTIVITIES IN OCCUPIED SPACES

- A. The Project Site is defined as the immediate rooms under construction at a given time. Any work in vertically or horizontally adjacent classrooms, hallways, MEP/IT/FP spaces and grounds outside the footprint indicated on the Site Utilization Plan shall be considered as being outside the Project Site. Areas outside the project site are identified as Occupied Spaces.
- B. The safety of building occupants and construction workers is paramount. All construction activities within Occupied Spaces shall be marked with cones and caution tape. Computer generated signage shall be provided indicating the path of travel around construction zones, and shall also be posted at stairwell doors indicating where internal construction activities may take place.
- C. Activities which require work in Occupied Spaces shall be specifically and clearly indicated on the Two-Week Look-Ahead and confirmed with the User Agency at least two (2) business days in advance.
- D. Sufficient time to clean up work zones shall be allocated at the end of the shift. All construction activities within the building shall be thoroughly vacuumed, wet mopped and cleaned to the satisfaction of the User Agency at the end of each shift.
- E. Use of exterior occupied spaces will be permitted during off-hours as permissible provided such use is coordinated with the User Agency at least 72 hours in advance.
- F. All construction materials, tools and debris must be removed from occupied building spaces once construction activities have ended for the day. Occupied spaces must be returned to original conditions to the greatest extent possible by 8am weekdays. If it is not feasible to do as such, notify the User Agency immediately. With approval, the area shall be cordoned off with cones and caution tape and computer generated signage shall be posted to the satisfaction of the User Agency.

1.6 TIME RESTRICTIONS AND WORKING HOURS

- A. Include in the Base Bid all costs of this coordination, including all premium time wages that may be required to meet these requirements and project schedule. Cost of all work done during second or third shifts or on weekends and holidays shall be included in the bid price.
- B. Disruptive Activities & Work Restrictions The College uses the following categories to indicate work activities allowable during certain time periods:
 - 1. No Work: on site work is prohibited to take place during this time. Workers are prohibited from the site without prior notification to the User Agency. In order to ensure the safety of

occupants and preserve the educational experience, work **MAY NOT** take place during the time periods specified in Paragraph C, below.

2. Quiet Work: vibration producing work may not occur. Work that generates noise or odors that would escape the project site and cause disruption to occupant in adjacent Occupied Spaces is prohibited. Disallowed activities include but are not limited to: demolition of block and concrete, use of jackhammers, saw cutting, hammer drilling, connecting to building structure, mechanical fastening and other work activities which provides loud noises or vibrations that are constant in nature. Use of heavy solvents, odious paints and other irritants which cannot be contained through mechanical or physical barriers prohibited. Work in Occupied Spaces prohibited unless specific, written authorization is requested and granted.
 - a. It is the sole discretion of the User Agency to determine if activities are considered disallowed during quiet work periods. The designation of disallowed activities is contingent on location within the job site and the activities of the occupants.
 - b. The contractor may request a "disturbance test" which may allow for some disallowed activities to take place during quiet work times. Contractor may request with 24 hour notice to run a limited test to determine if a specific activity in a set location can be performed during quiet work periods. The User Agency will observe the impact on the occupied areas and determine if the activity take place. Waivers resulting from disturbance tests will be valid for a set period of time, based on construction activities and occupant usage.
 3. No Restrictions: normal construction activities may take place. No restrictions on noise or vibrations. Utility shutdowns may occur following proper notifications.
 - a. This project's unrestricted hours are 10pm-8am Sunday-Friday and weekends between 5pm Friday and 8am Monday.
 - b. There are not classes on the following days and therefore have no work restrictions:
No work restrictions on Monday – Friday from 7:00 am – 4:00 pm. Contractor to coordinate with Owners project manager for any specific calendar school events, that the contractor will need to work around. The contractor shall account for any premium time required to meet the substantial completion date of June 15th,2025 in their base bid
- C. Working Hours
1. Contractor is expected to plan and execute the work on schedule within the parameters indicated above. Regular working hours for contractors are between 7:00 a.m. and 4:00 p.m., Monday through Friday. Work that is to take place outside of these timeframes are to be reflected on the Two Week Look-Ahead.
 2. Contractor is permitted to work holidays, nights and weekends if it is communicated two (2) business days in advance.
 3. In the event of adverse weather, the College is open unless a State of Emergency is called by the Governor. The College is not responsible for lost time due to weather. Contractor to communicate with Project Manager regarding the college's status.
 4. Special Work Hours are called for the following activities:
 - a. No Work Hours: Contractor to coordinate with Owner's project manager for any specific calendar school events, performances/etc. that the contractor will need to work around for facility access.

- b. Quiet Work: Contractor to coordinate with Owner's project manager for any specific calendar school events, performances/etc. that the contractor will need to work around.
- c. Hours of No Restrictions: No work restrictions from 7:00 am – 4:00 pm. Contractor to coordinate with Owner's project manager for any specific calendar school events, performances/etc. that the contractor will need to work around
- d. Hoisting: Contractor to provide any anticipated hoisting activities in their schedule. Contractor must coordinate with Rhode Island College and Owner's project manager to allow for flexibility and scheduling for contractor, Rhode Island College, and Owner's project manager.
- e. Material deliveries: Contractor to provide any anticipated material deliveries in their schedule. Contractor must coordinate with Rhode Island College and Owner's project manager to allow for flexibility and scheduling for contractor, Rhode Island College, and Owner's project manager.

1.7 SCHEDULE COORDINATION

- A. The contractor shall provide, in writing, via email, by noon on Thursdays the two week project look ahead which lists in detail the planned activities, locations of disturbance, scheduled subcontractors and working hours for the forthcoming Sunday-Saturday. The same shall be provided for the second week, but as a working draft. The document shall list out any utility shutdowns or other activities which require review and approval of the User Agency. Failure to provide the Look Ahead may result in a reduction of payment of general requirements line item in the following pay requisition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 17 90 – UTILITY PLANNING AND INTERRUPTIONS**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. This section details the minimum coordination requirements for system connections and service interruptions that may be required for new construction and renovation projects.
- B. Requirements.
- C. Outage Types.
- D. Outage Planning.
- E. Outage Requirements.
- F. Scheduling.
- G. Outage Coordination

1.2 REQUIREMENTS

- A. If a project or contract work requires the shutdown or de-energizing of any campus utility or building system, Contractor shall notify, in writing, the User Agency's Project Manager at least ten (10) calendar days in advance of the planned outage. User Agency's Project Manager shall be responsible for contacting Facilities Operations and scheduling a meeting to review the shutdown. (Refer to Scheduling section).
- B. In general, Contractors are not allowed to operate valves open or closed, or energize and de-energize switches without prior coordination and approval from the User Agency. Exceptions to this policy are for new construction or within buildings that are closed for total renovation, where the utilities affected are within the construction zone and have been verified ahead of time not to have an adverse effect on other building or campus operations.
- C. Chilled water, high temperature hot water and steam shutdowns can be scheduled only during off-peak seasons with limited exceptions such as an emergency repair.
- D. Contractors shall coordinate to have the building fire alarm system disabled prior to performing any work, such as cutting or welding that may cause inadvertent operation of the fire alarm system, ("Hot Work") and arrange for it to be enabled at the completion of the work.
- E. "Hot work" permits are required prior to any cutting and welding operations within buildings; follow all policy safety precautions.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION**

3.1 OUTAGE TYPES

UTILITY PLANNING AND INTERRUPTIONS

- A. There are three general types of outages, depending upon the impact that the work will have on existing building infrastructure and campus utilities. The level of planning and detail coordination required varies for each, as noted below.
1. Independent Outages:
 - a. Independent outages typically have no impact on existing campus utilities, operating communications infrastructure, building occupants or building systems. Examples include work within new building construction or “gut” building renovations, or installation of new campus utilities not yet in service.
 - b. For independent outages, the Contractor shall contact the User Agency’s Project Manager to coordinate the outage scheduling, as well as outage notification, to other College departments and building Users affected by this work. Facilities Operations support is not required for this type of outage.
 2. Minor Outages:
 - a. Minor outages typically have a limited impact on existing campus utilities, including operating communications infrastructure within the project site or running through the site; building occupants or building systems. Examples include fire alarm zone lock-outs for welding or other “Hot work” permits, to suit the installation of new fire alarm devices, or for branch line water shut-offs to suit connections of new plumbing fixtures.
 - b. For Minor outages, limited College coordination is required; the Contractor shall contact the User Agency’s Project Manager to coordinate the outage scheduling with Facilities Operations and the College’s trade staff. Details of the outage work will be developed as a general scope of work.
 - c. Project Manager will also coordinate the outage notification to other College departments and building Users affected by this work. Minimum outage notification times are required and an outage coordination meeting prior to the outage is required to review outage scope and details (See Scheduling section).
 3. Major Outages:
 - a. Major outages typically have a significant impact on existing campus utilities, communication systems and infrastructure, building occupants or building systems. Examples include shut down of building electrical power systems, central heating and cooling systems, shutdown of BAS and fire alarm systems, or shutdown of campus water, heating and chilled water systems.
 - b. For Major outages, significant coordination is required for both the Contractor and the User Agency. Determination of major outages will be made in the Project Planning phase. Details of the outage work, and general outage scheduling will be developed during the design phase as an outage checklist (OCL).
 - c. During the construction phase, Contractor shall coordinate outage scheduling with the User Agency’s Project Manager who will contact Facilities Operations to coordinate the required to support the outage work, as well as develop work orders for Trades support.
 - d. User Agency’s Project Manager will also coordinate the outage notification to other College departments and building Users affected by this work. Minimum outage notification times are required and an outage coordination meeting prior to the outage is required to review outage scope and details (See Scheduling section).

UTILITY PLANNING AND INTERRUPTIONS

3.2 OUTAGE PLANNING

- A. The Contractor will utilize the Utility & Critical System Outage Checklist deliverables provided in the Design phase and incorporate all required outages into their project construction schedule as milestone activities.
- B. The Contractor shall utilize and update the draft Utility & Critical System Outage Checklist(s) (OCLs) (as developed by the Design Agent) based on their proposed project schedule and plan for construction.
- C. The updated Utility & Critical System Outage checklist shall be used for required outage coordination review meetings to review and confirm the outage impacts and resources required to support the outage from the College, the project team or others. Updated outage checklists shall clearly identify:
 - 1. Project impacts (what buildings, utility systems and/or system loads are impacted by the work).
 - 2. Any updates determined in the course of Contractor's physical walkdown and verification of what systems and equipment are affected by the proposed shutdown.
 - 3. Outage schedule (time/date of when work will be performed and outage durations), including contingency communications for work that will extend beyond schedule;
 - 4. Required prep work to be completed or to be in place prior to support the actual outage work (install portable generator(s), pipe flushing procedures, filling and venting procedures, etc.).
 - 5. Brief description of the actual outage work and essential tasks being performed during the outage (Switches or valves being opened/closed, piping connections, etc.);
 - 6. Note key coordination issues that need to be included as a part of the outage (need for portable generators to maintain power, street closure(s), police details, etc.).
 - 7. For hydronic systems, include how system draining, flushing, refilling and venting will be accomplished.
 - 8. For building electrical system outages, include copies of the panelboard schedules for all affected electrical equipment (panelboards, switchboards, motor control centers, etc.).
 - 9. Review and identify any potential outage impacts that may affect ongoing critical Research and Academic activities: i.e.: campus water and/or electrical services; building ventilation and exhaust systems, BAS controls, etc.
 - 10. Listing of key contacts and phone numbers for the Contractor, Facilities Operations, Information Technology Services (ITS) DPS staff, and affected building staff.
- D. As a prerequisite of outage planning and preparations, it is the responsibility of the Contractor to perform their own visual inspection and walk down to verify what utilities and systems will be physically affected by the shutdown. This effort shall be made after review of available Record documentation, and consultations with the Design Agent, User Agency's Project Manager and Facilities Operations, as well as other affected College departments, such as Environmental Health & Safety, Informational Technology, etc. The intent of the physical inspection and walkdown is to:
 - 1. Verify known systems and system loads that will be affected by the outage.

UTILITY PLANNING AND INTERRUPTIONS

2. Identify any other undocumented systems and loads that may be affected by the proposed outage.
3. Verify locations of existing system isolation switches, valves, bypasses, and temporary services.

3.3 OUTAGE REQUIREMENTS

- A. Facilities Operations shall be notified for all interruptions that affect building fire alarm and detection systems, fire suppression systems (fire sprinklers, kitchen hood suppression systems, dry systems, clean agent or Halon suppression systems), fire pumps and water distribution lines that connect to fire suppression systems.
- B. For Research facilities, Facilities Operations shall be notified of all interruptions affecting: fume hoods, HVAC supply and exhaust systems, Potable and non-Potable water systems, electrical, heating and cooling systems and Process cooling systems.
- C. The College's Information Technology Services (ITS) office requires notification for all communications systems and infrastructure outages and interruptions that affect telephone or network services.
- D. Proper Lockout/Tagout procedures shall be followed by both the Contractor and College's staff.

3.4 SCHEDULING

- A. Outage dates shall be coordinated with the College's Academic calendar and identified blackout (no outage work) periods. Outages will occur off hours unless otherwise approved by the User Agency.
- B. Independent Outages: Per the User Agency's discretion.
- C. Minor Outages: normal workday hours; 48-hour minimum advance notice. Weekend/off-hours; 72-hour minimum advance notice. Actual outage scheduling is subject to User Agency's staff availability.
- D. Major Outages: As determined by draft Utility & Critical System Outage checklist: minimum (2) week notice after approval; (4) weeks is preferred for major shutdowns.
- E. The User Agency's Project Manager will assist the Constructor in the scheduling, as well as the notification of, related building Users and other College departments affected by this work.
- F. Steam Shutdowns must be coordinated through the Project Manager. Facilities Management will perform all steam shutdowns. The contractor must provide a minimum of ten (10) calendar days' notice to the Project Manager for a pre-scheduled shutdown. The pre-scheduling must take place as far in advance as practicable, and no later than 30 days in advance.

3.5 OUTAGE COORDINATION

- A. The Project Manager shall coordinate the shutdown details required for the project with the Facilities and Operations staff, the project team, Campus Police, and the Building Users (as required by the particular system interruption).

UTILITY PLANNING AND INTERRUPTIONS

- B. A coordination meeting shall be held with representatives of the Contractor, affected building Users, and other concerned parties to review the planned outage sequences and timing. Facilities Operations staff will generally advise of what campus operations and building Users will be affected by the proposed outage or shutdown; the Project Manager is in turn responsible to contact all the affected groups to determine the proper time for the shutdown and any special requirements to be provided during the shutdown.
- C. A Utility and Critical System Outage Checklist (OCL) is required to be filled out for each major outage by the Design Agent and Contractor, with support from the Project Manager. The checklist includes relevant pre-outage work required prior to the outage, sequence(s) of work to be performed during the outage, expected outage times and durations, and key contact (cell phone) information for the Contractor, Facilities Operations staff, other affected College Department staff and affected Users. The completed checklist requires sign-off from the Facilities Operations Director.
- D. The Project Manager will submit the signed outage checklist to Facilities Operations, who will then assign to the appropriate staff to perform and monitor the shutdown. The Project Manager will also formally notify all affected parties of the planned outage date(s) by e-mail and physical posting of the impacted buildings.

END OF SECTION

01 20 00 – PRICE AND PAYMENT PROCEDURES**PART 1 - GENERAL**

1.1 SECTIHES ON INCLUDES

- A. Sales tax exemption.
- B. Allowances.
- C. Testing and inspection allowance.
- D. Unit prices.
- E. Alternates.
- F. Schedule of values.
- G. Applications for payment.
- H. Change procedures.
- I. Defect assessment.
- J. Warranty inspection retainage.
- K. Waiver of Lien Form
- L. MBE Compliance Form

1.2 TAX EXEMPTION

- A. The State of Rhode Island is exempt from payment of any federal or state excise, transportation, or sales tax. Refer to A201-2007 General Conditions §3.6.2.
 - 1. Place exemption certificate number on invoice for materials incorporated in the Work of the Project.
 - 2. Furnish copies of invoices to Owner.
 - 3. Upon completion of Work, file a notarized statement with Owner that all purchases made under exemption certificate were entitled to be exempt.
 - 4. Pay legally assessed penalties for improper use of exemption certificate number.

1.3 ALLOWANCES

- A. Refer to A201-2007 §3.8 for Allowance provisions. General Contractor overhead and profit, bonding and other fees should be calculated into the Contract Sum and may not be assessed on Allowance Usage.
- B. Design Agent Responsibility:
 - 1. Consult with Contractor for consideration and selection of products, suppliers, and Installers.
 - 2. Select products in consultation with User Agency and transmit decision to Contractor.
 - 3. Prepare Change Order to account for the use of allowance.
- C. Contractor Responsibility:

1. Assist Design Agent or its Consultants in selection of products, suppliers and installers.
2. Obtain proposals from suppliers and installers, and offer recommendations.
3. On notification on selection by Design Agent, execute purchase agreement with designated supplier and installer.
4. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
5. Modify the Schedule of Values to provide line items for each approved use of an allowance.
6. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.

D. Schedule of Allowances: Allowances

1. Please refer to the Bid Form for the list of Allowances.

1.4 TESTING AND INSPECTION ALLOWANCE

- A. All costs of regularly scheduled testing are included in the Base Bid. See Bid Form for allowance to cover costs of additional testing to be provided when directed by the User Agency.
- B. See Section 01 40 00 and its attachment for testing requirements.

1.5 UNIT PRICES

- A. See Section 01 22 00.

1.6 ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the User Agency's option. Accepted Alternates will be identified in the Purchase Order.
- B. Coordinate related work and modify surrounding work as required.
- C. Schedule of Alternates: See Section 01 23 00.

1.7 SCHEDULE OF VALUES

- A. Refer to A201-2007 General Conditions §9.2 for Schedule of Values provisions. Contractors are encouraged to submit the Schedule of Values as soon as practical after contract commencement, but within the duration indicated in the General Conditions.
- B. Schedule of Values (SOV) shall only be accepted on an original AIA Form G702 - Application and Certificate for Payment and AIA G703 - Continuation Sheet.
- C. Format:
 1. Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the major specification Section.
 2. At a minimum, provide line items under the heading General Conditions for: Site Mobilization, Bonds, Insurance, Permits, Construction Schedules, Temporary Facilities, Project Management & Supervision, General Cleaning, and Dumpsters & Trash Removal. The Design Agent and User Agency reserves the right to request further breakout beyond those requested here.
 3. At a minimum, provide line items under the heading Closeout for: Final Cleaning, Monetized Punchlist (zero value at start of contract), Administrative Closeout, Owner's Manual,

Project Record Documents and Warranty Retainage (.5%). The Design Agent and User Agency reserves the right to request further breakout beyond those requested here.

4. Per A101-2017 §5.5, out of state firms shall also include a "Foreign Company" line item valued at 3% of the Contract Sum.
 5. Provide separate line items for Labor and Materials where the value is greater than \$10,000.
 6. Provide separate line items where multiple vendors or subcontractors are providing services.
 7. No single line item shall exceed twenty percent (20%) of the total contract.
 8. Identify each Allowance as a line item.
 9. Identify each Alternate as a line item.
- D. Submit for review and approval to the Design Agent and User Agency the Schedule of Values prior to the first Application for Payment. Indicate in the email the intended date for each progress payment, typically the last day of the month. The first Application for Payment will not be accepted until the SOV is approved.
- E. Revisions:
1. Once approved, the SOV shall only be revised to accommodate changes to the Contract Value.
 2. Revise SOV to list changes to the contract value for which a revised Purchase Order has been issued. Provide a heading for the Change Order Number and list Change Order Proposals comprising said Change Order as individual lines on the SOV.
 3. As Allowances are used, under the heading for the appropriate allowance, list Change Order Proposals charged to the Allowance as individual lines on the SOV. For unit cost Allowances, identify quantities taken from Contract Documents multiplied by the unit cost to achieve the total for the item.

1.8 APPLICATIONS FOR PAYMENT

- A. See General Conditions §9.3 for Applications for Payment provisions. Contractors shall submit for payment on a monthly basis.
- B. Prepare a draft version "pencil copy" of each application.
1. The Pencil Copy shall be distributed via email ten (10) calendar days prior to the established date for progress payment for review by Design Agent and User Agency's representative.
 2. Accompanying the Pencil Copy, Contractor shall provide a summary list of all subcontractors who performed work on the site for the month.
 3. Design Agent and User Agency's representative shall review the Pencil Copy and request adjustments as appropriate.
 4. Contractor shall make agreed revisions and prepare final for payment
- C. Submitting for Payment
1. Prepare one (1) original of the approved AIA Form G702 - Application and Certificate for Payment and AIA G703 - Continuation Sheet, accompanied by three (3) copies.
 2. Individually sign and notarize and emboss with notary's official seal, the original and each of the three (3) copies. Deliver to Design Agent for further processing and distribution.

3. Applications not including original copyrighted AIA G702, and G703 Forms, will be rejected, and returned for re-submittal.
 4. Applications not properly signed and notarized will be rejected, and returned for re-submittal.
- D. An Application for Payment is not considered acceptable per the Prompt Payment Policy until the signed, notarized and certified AIA G702 and G703 Forms with ALL required enclosures are received. Applications submitted without the following items described in this section and its attachments will be returned for resubmittal. These items shall be sent via email to the User Agency's Representative. Failure to provide items listed below with the Application for Payment submission will result in a delay in processing and may result in a reduction in the amount of said Application for Payment.
1. Transmittal letter as specified for Submittals in Section 01 33 00.
 2. Updated construction schedule, prepared per Section 01 33 00.
 3. Statement signed by the Contractor's firm principal certifying that there are no unidentified outstanding claims for delay.
 4. Beginning with the second Application for Payment, Certified Monthly Payroll Records for all workers on site for the previous month.
 - a. Forms for the submission of Certified Payroll Records may be found from the Rhode Island [Prevailing Wage Website](#) in either PDF or Excel formats. These forms must be used on monthly submittals.
 5. Beginning with the second Application for Payment, Contractor's right to payment must be substantiated by documenting, on a copy of the RIC Waiver of Lien Form included in this Project Manual, that payment monies due, less retainage not exceeding five (5) percent, have been paid in full to subcontractor and suppliers for work, materials, or rental of equipment billed for under specific line item numbers in the immediately preceding application.
 6. Affidavits attesting to off-site stored products with insurance certificates as requested.
 7. Digital Photographs as specified in Section 01 33 00. Provide as a link.
 8. Updated Submittal Log.
 9. Identify Apprenticeship hours required under RIGL 37-13-3.1 for all contracts over \$1million in value.
 10. A Minority Utilization Report for minority subcontractors must be included. Use the form provided.
 11. Additional Substantiating Data: When the User Agency or Design Agent requires additional substantiating information from the review of the "pencil copy," submit data justifying dollar amounts in question.

1.9 CHANGE PROCEDURES

- A. Refer to AIA A201-2007 as amended by the state, General Conditions §7.
- B. Submittals: Submit name of the individual authorized to receive change documents and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.
- C. Types of Change Proposals

1. Stipulated Sum Change Order: Based on Proposal Request and Contractor's Change Proposal as approved by Design Agent. All quotations shall include detailed material costs and labor hour and rate breakouts.
 2. Unit Price Change Order: For contract unit prices and quantities, the Change Order will be executed on a fixed unit price basis. For unit costs or quantities of units of work which are not pre-determined, execute the Work under a Construction Change Directive. Changes in the Contract Sum or Contract Time will be computed as specified for a Time and Material Change Order.
 3. Time and Material Change Order: Submit an itemized account and supporting data after completion of the change, including timeslips signed by User Agency's representative, within the time limits indicated in the Conditions of the Contract. The Design Agent will determine the change allowable in the Contract Sum and Contract Time as provided in the Contract Documents. Only User Agency-representative-signed timeslips will be considered.
- D. The Design Agent may issue a Proposal Request which includes a detailed description of a proposed change with supplementary or revised Drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required, and the period of time during which the requested price will be considered valid. Contractor will prepare and submit the Change Proposal within fifteen (15) calendar days.
- E. The Contractor may propose changes by submitting a Change Proposal request to the Design Agent and User Agency, describing the proposed change and its full effect on the Work. Include a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation, and a statement describing the effect on Work by separate or other Contractors. Document any requested substitutions in accordance with Section 01 60 00.
- F. For all Change Proposals, maintain detailed records of work done on a Time and Material basis. Submit timeslips daily for verification and sign-off by User Agency's representative on-site. Provide full information required for an evaluation of the proposed changes, and to substantiate costs for the changes in the Work.
- G. Document each quotation for a change in cost or time with sufficient data to allow an evaluation of the quotation. Provide detailed breakdown of costs and estimates for labor and materials including a detailed breakdown for subcontractor's or vendor's Work. Include copies of written quotations from subcontractors or vendors.
- H. Construction Change Directive: refer to General Conditions §7.3. Design Agent may issue a directive, on AIA Form G714 as amended by the state.
- I. For Minor Changes, §7.4: The Design Agent will advise of minor changes in the Work not involving an adjustment to Contract Sum or Contract Time by issuing supplemental instructions on AIA Form G710 as amended by the state.
- J. Change Order Forms: AIA G701 as amended by the state Change Order.
- K. Execution of Change Orders: The Design Agent will issue Change Orders for signatures of the parties as provided in the Conditions of the Contract. Electronic signatures are acceptable. Design Agent shall also issue a Letter of Justification to accompany the Change Order.
1. The approved Change Order amount shall include all compensation to the Contractor, including but not limited to Overhead and Profit, General Conditions, Material, Labor, Equipment and other costs. Following the execution of the Change Order, no additional compensation for the work covered in the Change Order shall be considered.
- L. Correlation Of Contractor Submittals:

1. Promptly revise the Schedule of Values and the Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum. Promptly revise progress schedules to reflect any change in the Contract Time, revise sub-schedules to adjust times for any other items of work affected by the change, and resubmit.
2. Promptly enter changes in the Project Record Documents.
3. Update Schedule of Values and Subcontractor List as required.

1.10 DEFECT ASSESSMENT

- A. Refer to General Conditions §12.2. Replace the Work, or portions of the Work, not conforming to specified requirements.
- B. If, in the opinion of the Design Agent, it is not practical to remove and replace the Work, the Design Agent will direct an appropriate remedy or adjust payment.
- C. The defective Work may remain, but the unit sum will be adjusted to a new sum at the discretion of the Design Agent.
- D. The defective Work will be partially repaired to the instructions of the Design Agent, and the unit sum will be adjusted to a new sum at the discretion of the Design Agent.

1.11 WARRANTY INSPECTION RETAINAGE

- A. One-half of one percent of the cost of the Work will be retained from Final Payment for duration of twelve (12) months from date of Substantial Completion. This shall be included in the Schedule of Values. If, after ten months, all systems including mechanical and electrical, are determined by the User Agency to be properly functioning, the Warranty Inspection Retainage will be released.
- B. If, after twelve (12) months, there are found to be modifications, adjustments, or corrections necessary to be made to address any system or product malfunction, in order to fulfill specified performance or requirements of such systems or products, release of the warranty inspection retainage will be delayed until such malfunctions are rectified.
- C. If, after twelve (12) months from the date of Substantial Completion, all systems have not been fully addressed, the User Agency may utilize the Warranty Inspection Retainage to hire others to execute necessary modifications, adjustments, or corrections.

1.12 WAIVER OF LIEN FORM

- A. RIC Document Waiver of Lien Form is included, following this page, as an integral part of the Contract documents. A copy with completed information must be submitted with the second and each succeeding Application for Payment.

1.13 MBE COMPLIANCE

- A. The MBE Compliance Form is included after this section. Contractors shall work with the RI Office of Diversity, Equity & Opportunity to ensure that all participation and reporting requirements are met.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 21 00 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions and applicable portions of Division 1 of the specification are a part of this Section, which shall consist of all labor, equipment and materials necessary to complete all allowance work indicated on the drawings and herein specified.

1.2 OTHER CASH ALLOWANCES

- A. Should allowances be included in other Sections of these specifications, follow the procedures of this Section, but include the cost of same under the respective Sections.

1.3 CASH ALLOWANCES DEFINITION

- A. Amount of each allowance includes:
 - 1. Net cost of product and/or service.
 - 2. Delivery and unloading at site.
 - 3. All soft costs, such as engineering, design, drafting, etc.
- B. Include in the Base Bid amount, and not part of the amounts of the allowances, the costs for:
 - 1. Handling at the site, including uncrating and storage.
 - 2. Protection from elements and from damage.
 - 3. Labor, installation and finishing.
 - 4. Other expenses, including incidental/appurtenant materials and labor required to complete the installation.
 - 5. Overhead and profit.

1.4 CASH ALLOWANCES

- A. Purchase materials and/or services under each allowance as directed by the Architect.
- B. Include the following amounts in Bid, for inclusion in the Base Bid:

Allowance #1 Carry \$20,000.00 to cover additional unforeseen conditions encountered on site of excavation beyond initial BID.

Allowance #2 Carry \$10,000.00 to cover additional unforeseen conditions encountered on site during new roof to existing roof tie-in beyond initial bid.

Allowance #3 Carry \$10,000.00 to cover additional unforeseen conditions encountered on bluestone panel removal to be replaced in-kind.

Allowance #4 Carry \$10,000.00 to cover planting and landscaping.

Allowance #5 Carry \$2,000.00 to cover (4) four new ADA compliant wayfinding signs per floor, above and beyond the signs already called for on the plans in the new elevator lobby.. Signs to be approximately 18"x18", exact design, text, and location TBD.

Total Allowance dollars to be carried in the Contractor's lump sum base bid price: **\$ 52,000**

1.5 PROCEDURES

C. Selection of Materials:

1. Assist Architect and Owner in determining qualified suppliers.
2. Obtain proposals from suppliers when requested by Architect and Owner.
3. Make appropriate recommendations for consideration by Architect and Owner.
4. Notify Architect and Owner of any effect anticipated by selection of product or supplier under consideration on:
 - a. Construction Schedule.
 - b. Contract Sum.
 - c. Facility operations.
 - d. Impact on Owner furnished items.
5. On notification of selection, enter into purchase agreement with designated supplier.

D. Delivery:

1. Arrange for delivery and unloading.
2. Promptly inspect products for damage or defects.
3. Submit claims for transportation damages.

E. Installation:

1. Comply with the requirements of the referenced specification section.

F. Adjustment of Costs:

1. Should the actual purchase cost be more or less than specified amount of allowance, Contract Sum will be adjusted by Change Order equal to amount of difference, provided accounting of expenditures is current, and accurate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 02 10

01 22 00 – UNIT PRICES**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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Related Requirements:
 - 1. Section 01 20 00 "Price & Payment Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

- A. Unit price is an amount incorporated in 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.
- B. Excavation quantities shall be measured on a volume basis as computed from original in-place position. Fill quantities shall be measured on a volume basis as computed from in-place position.
- C. No removed material shall be calculated against more than one category of allowance.

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, 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. User Agency 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 User Agency's expense, by an independent surveyor acceptable to Contractor.

1.5 SCHEDULE OF UNIT PRICES

- A. Please refer to the Bid Form for the list of Unit Costs. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION**

A. SCHEDULE OF UNIT PRICES

1. **Suitable Structure Fill Material \$/CY**

- a. Description: Structure Fill Material, in-place from off-site, placed by power equipment
- b. Unit of Measurement: cu. yd. (Cubic Yard)

2. **Loam & Topsoil \$/CY**

- a. Description: Fine grading and seeding for general lawns in accordance with Division 32, Section "Turfs and Grasses."
- b. Unit of Measurement: cu. yd. (Cubic Yard)

3. **Gravel \$/CY**

- a. Description: Compacted gravel under slab, in-place excluding fine grading.
- b. Unit of Measurement: cu. yd. (Cubic Yard)

4. **Air entrained, Concrete Walkway & Paving \$/CY**

- a. Concrete in-place, reinforcement 4000 psi, air entrained.
- b. Unit of Measurement: cu. yd. (Cubic Yard)

5. **Concrete in-place (flat work interior) \$/CY**

- a. Concrete in-place, reinforcement 3500 psi
- b. Unit of Measurement: cu. yd. (Cubic Yard)

END OF SECTION 01 22 00

SECTION 01 25 00 - SUBSTITUTION PROCEDURES

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Division 01 Section "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
 - 2. Divisions 02 through 10 Sections for specific requirements and limitations for substitutions.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use CSI Form 13.1A
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size,

- durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.
- 1.5 QUALITY ASSURANCE
- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.
- 1.6 PROCEDURES
- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Not permitted.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Division 01 Section "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, Architect's Supplemental Instructions.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within [time specified in Proposal Request] [or] [15 days, when not otherwise specified,] after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. Quotation Form: Use CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, "Proposal Worksheet Detail."

- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 4. Include costs of labor and supervision directly attributable to the change.
 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 6. Comply with requirements in Division 01 Section "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
 7. Proposal Request Form: Use CSI Form 13.6A, "Change Order Request (Proposal)," with attachments CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, "Proposal Worksheet Detail"

1.5 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: See Division 01 Section "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
- B. Unit-Price Adjustment: See Division 01 Section "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.6 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Changes Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

1.7 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a [Construction] Change Directive on [AIA Document G714] [EJCDC Document C-940] [form included in Project Manual]. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Division 01 Section "Allowances" for procedural requirements governing the handling and processing of allowances.
 - 2. Division 01 Section "Unit Prices" for administrative requirements governing the use of unit prices.
 - 3. Division 01 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 4. Division 01 Section "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Submittal schedule.
 - c. Items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect at earliest possible date, but no later than ten days before the date scheduled for submittal of initial Applications for Payment.

- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 2. Arrange schedule of values consistent with format of AIA Document G703.
 3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
 4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 - a. Include separate line items under Contractor and principal subcontracts for LEED documentation and other Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
 5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
 6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
 7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
 8. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.

9. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate owner payments or deposits, if any, and balance to be paid by Contractor.
10. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
11. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The period covered by each Application for Payment is one month, ending on the last day of the month.
 1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.
- C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
 1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.

2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- F. As-Built documentation: As-Built documentation is required as a condition for application of payment processing and approval. Documentation is to be provided for Owner and/or Architect to review at the time of the draft review of the monthly application, but no later than five days prior to submission of the application for payment. Failure to maintain the as-built documentation may result in delay of the processing of the Application for Payment until such time as the as-built documentation is provided for review.
- G. LEED Documentation: LEED documentation and or interim progress, required during construction shall be submitted with the Application for Payment indicating progress as appropriate. Failure to maintain the LEED documentation may result in delay of the processing of the Application for Payment until such time as the LEED documentation and/or interim progress is provided for review.
- H. Transmittal: Submit four signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- I. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit executed waivers of lien on forms, acceptable to Owner.
- J. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Products list (preliminary if not final).
 5. Schedule of unit prices.

6. Submittal schedule (preliminary if not final).
 7. List of Contractor's staff assignments.
 8. List of Contractor's principal consultants.
 9. Copies of building permits.
 10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 11. Initial progress report.
 12. Report of preconstruction conference.
 13. Certificates of insurance and insurance policies.
 14. Performance and payment bonds.
 15. Data needed to acquire Owner's insurance.
- K. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- L. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Contract Sum.
 4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
 5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
 6. AIA Document G707, "Consent of Surety to Final Payment."
 7. Evidence that claims have been settled.
 8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 9. Final liquidated damages settlement statement.
 10. Build code required contractor certification.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

01 30 00 – ADMINISTRATIVE REQUIREMENTS**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Pre-Award Meeting.
- B. Site Administration.
- C. Coordination and Project Conditions.
- D. Preconstruction Meeting.
- E. Site Utilization Plan.
- F. Preconstruction Video.
- G. Site Mobilization Meeting.
- H. Progress Meetings.
- I. Digital Photographs of Progress.
- J. Pre-installation Meetings.

1.2 PRE-AWARD MEETING

- A. Following the issuance of the Notice of Tentative Award from the RI State Purchasing Office, the Design Team, User Agency and Contractor shall convene as soon as possible for a Pre-Award Meeting.
- B. The Architect shall prepare meeting minutes and provide to the User Agency in Microsoft Word format within two (2) business days of the meeting. The User Agency shall review and make edits as required and transmit to the Contractor for review and acceptance. Upon the receipt of an email indicating the Contractor's acceptance of the minutes, the User Agency shall prepare the AIA Contract and General Conditions.
- C. Agenda
 - 1. Introductions.
 - 2. Roles, responsibilities and lines of communications.
 - 3. Site utilization expectations.
 - 4. Anticipated schedule.
 - 5. Thorough Scope Review, using form generated by the User Agency and Design Agent. Form shall become part of the Contract Documents.
 - 6. Discussion of inspections, testing, verification and commissioning.
 - 7. Review of pre-award and post-contract documents, deliverables and requirements.

1.3 SITE ADMINISTRATION

- A. Maintain a daily attendance log to include the names of all project employees and guests to the site. Each guest signing the log should indicate a brief description of the reason for the visit, the guest's employer or organization. The log sheet, or sheets, must clearly indicate the Project Name, and the name of the general Contractor. Each line in the log should allow for

the name of that employee, the employee's job title (use terminology used by prevailing wage job title), and the name of that employee's employer. This log shall be kept on a uniform form prescribed by the Director of Labor and Training. Such log shall be available for inspection on the site at all times by the Purchaser, Owner, User Agency, and/or the Director of the Department of Labor and Training and his or her designee. Provide copies when requested.

B. Daily Attendance Form

1. Maintain Daily Attendance Form acceptable to the Department of Labor and Training for all projects with a contract value over \$1 Million. Submit as requested.

1.4 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate the scheduling, submittals, and the Work of the various Sections of the Project Manual to ensure an efficient and orderly sequence of the installation of interdependent construction elements.
- B. Verify that the utility requirements and characteristics of the operating equipment are compatible with the building utilities. Coordinate the Work of the various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate the space requirements, supports and installation of the mechanical and electrical Work, which are indicated diagrammatically on the Drawings. Follow the routing shown for the pipes, ducts, and conduit, as closely as practicable; place runs parallel with the lines of the building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. Coordinate the completion and cleanup of the Work of the separate Sections in preparation for Substantial Completion and for portions of the Work designated for the User Agency's partial occupancy.
- E. After the User Agency's occupancy of the premises, coordinate access to the site for correction of defective Work and the Work not in accordance with the Contract Documents to minimize disruption of the User Agency's activities.

1.5 PRECONSTRUCTION MEETING

- A. The Design Agent will schedule a meeting after a Purchase Order is issued to the Contractor.
- B. Attendance Required: User Agency's Representative, Design Agent, and Contractor.
- C. Agenda:
 1. Distribution of the Contract Documents.
 2. Review of submission of contractually required deliverables: Superintendent Qualifications, procurement timeline and list of Subcontractors, list of products, submittal log with timelines, schedule of values, project schedule, site safety procedures and mobilization schedule.
 3. Designation of the personnel representing the parties in the Contract and the Design Agent.
 4. The procedures and processing of requests for information, site access, field decisions, submittals, substitutions, applications for payments, proposal requests, Change Orders, and Contract closeout procedures.
 5. Scheduling.

- D. The Design Agent shall record the minutes and distribute copies within two (2) days of the meeting to the participants, with copies to the Contractor, User Agency, other participants, and those consultants affected by the decisions made.

1.6 SITE UTILIZATION PLAN

- A. Refer to Drawings for approximate area for site staging.
- B. Refer to Section 01 50 00 Temporary Facilities and Controls for specific requirements.
- C. A Site Utilization Plan shall be submitted by the Contractor within ten (10) business days of issuance of the Purchase Order for approval by the User Agency.

1.7 PRECONSTRUCTION VIDEO

- A. Conduct a pre-construction survey of the project site and areas immediately adjacent to the site. Submit two (2) copies of the video on thumb drive to the User Agency.

1.8 SITE MOBILIZATION MEETING

- A. The Design Agent will schedule a meeting at the Project site prior to the Contractor's occupancy and may occur at the same time as the Preconstruction meeting noted above.
- B. Attendance Required: The User Agency, Design Agent, Contractor, the Contractor's Superintendent, and major Subcontractors.
- C. Agenda:
 - 1. Use of the premises by the User Agency and the Contractor.
 - 2. The User Agency's requirements and partial occupancy.
 - 3. Construction facilities and controls provided by the User Agency.
 - 4. Temporary utilities provided by the User Agency.
 - 5. Security and housekeeping procedures.
 - 6. Schedules.
 - 7. Application for payment procedures.
 - 8. Procedures for testing.
 - 9. Procedures for maintaining the record documents.
 - 10. Requirements for the start-up of equipment.
 - 11. Inspection and acceptance of the equipment put into service during the construction period.
- D. Contractor shall record the minutes and distribute the copies within two days after the meeting to the participants, with copies to the Design Agent, User Agency, other participants, and those consultants affected by the decisions made.

1.9 PROGRESS MEETINGS

- A. Schedule and administer the meetings throughout the progress of the Work at weekly intervals while work is in process.
- B. Make arrangements for the meetings, prepare the agenda with copies for the participants, and preside at the meetings.

- C. Attendance Required: The job superintendent, major subcontractors and suppliers, the User Agency, Design Agent, and Consultants as appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review the minutes of previous meetings.
 - 2. Review of the Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of the problems which impede the planned progress.
 - 5. Review of the submittals schedule and status of the submittals.
 - 6. Review of delivery schedules.
 - 7. Maintenance of the progress schedule.
 - 8. Corrective measures to regain the projected schedules.
 - 9. Planned progress during the succeeding work period.
 - 10. Coordination of the projected progress.
 - 11. Maintenance of the quality and work standards.
 - 12. Effect of the proposed changes on the progress schedule and coordination.
 - 13. Other business relating to the Work.
- E. Contractor shall record the minutes and distribute the copies within two days after the meeting to the participants, with copies to the Design Agent, Consultants, User Agency, participants, and others affected by the decisions made.

1.10 DIGITAL PHOTOGRAPHS OF WORK PROGRESS

- A. Submit minimum 12 digital photographs of construction progress each month. Include both jpg. and reduced-size pdf versions for email use. Refer to Price and Payment Procedures 01 20 00
- B. Include an additional minimum of 12 photographs documenting underground utilities when installed in relationship to visible site features.
- C. Include photographs of important in-wall or ceiling utilities before close-in at appropriate stages of construction.
- D. See Section 01 78 00 for close-out copy requirements of these files.

1.11 PREINSTALLATION MEETINGS

- A. When required in the individual specification Sections or listed below, convene a pre-installation meeting at the site prior to commencing the Work of the Section. Pre-installation Meetings:
 - 1. The following items of work will require pre-installation meetings:
 - a. Temporary HVAC systems
 - b. Network and Telecommunication wiring and systems.
 - c. Network and Telecommunication data rack connections.
 - d. Fire Alarm and Sprinkler demolition and installation.
 - e. Door Access and Security Systems

- f. Roofing sequencing and installation
 - g. Insert any other variations.
- B. Require attendance of the parties directly affecting, or affected by, the Work of the specific Section.
 - C. Notify the Design Agent four days in advance of the meeting date.
 - D. Prepare an agenda and preside at the meeting:
 - 1. Review the conditions of installation, preparation and installation procedures.
 - 2. Review coordination with the related work.
 - E. Record the minutes and distribute the copies within two days after the meeting to the participants, with copies to the Design Agent, User Agency, participants, and those Consultants affected by the decisions made.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION (NOT USED)****END OF SECTION**

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

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.

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Requests for Information (RFIs).
 - 4. Project Web site.
 - 5. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Division 01 Section "Multiple Contract Summary" for a description of the division of work among separate contracts and responsibility for coordination activities not in this Section.
 - 2. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 3. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 4. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

- A. RFI (Request for information) Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use a industry standard form that include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.

3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, on Project Web site, and by each temporary telephone. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors when appropriate and/or required, to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.

4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings, at a scale not less than 1/4" = 1'-0", according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to

- accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 9. U.L. fire-rated walls shall be indicated.
 10. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
 11. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Division 01 Section "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Preparation Format: DWG, Version ACAD 2009, operating in Microsoft Windows operating system.
 3. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format and Portable Data File (PDF) format.
- D. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- E. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect (and Construction Manager when identified).
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- F. RFI Forms: Contractors standard AIA form or AIA Document G716, Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- G. Architect's Action: Architect and Construction Manager will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."

- a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 7 days of receipt of the RFI response.
- H. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use forms and/or Software log that is part of a Project Web based site with not less than the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect (and Construction Manager when required).
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's (and Construction Manager's) response was received.
- I. On receipt of Architect's (and Construction Manager's) action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect (and Construction Manager) within five (5) days if Contractor disagrees with response.
1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.7 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Construction Manager, and Architect, within three (3) days of the meeting.
- B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than ten (10) days after execution of the Agreement.
1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, Owner'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.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.

- e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Preparation of record documents.
 - m. Use of the premises and/or and existing building.
 - n. Work restrictions.
 - o. Working hours.
 - p. Owner's occupancy requirements.
 - q. Responsibility for temporary facilities and controls.
 - r. Procedures for moisture and mold control.
 - s. Procedures for disruptions and shutdowns.
 - t. Construction waste management and recycling.
 - u. Parking availability.
 - v. Office, work, and storage areas.
 - w. Equipment deliveries and priorities.
 - x. First aid.
 - y. Security.
 - z. Progress cleaning.
4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, and Owner's Commissioning Authority of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.

- t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing operations and maintenance data.
 - e. Requirements for delivery of material samples, attic stock, and spare parts.
 - f. Requirements for demonstration and training.
 - g. Preparation of Contractor's punch list.
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - i. Submittal procedures.
 - j. Coordination of separate contracts.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at weekly and/or regular intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants

- at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site utilization.
 - 9) Temporary facilities and controls.
 - 10) Progress cleaning.
 - 11) Quality and work standards.
 - 12) Status of correction of deficient items.
 - 13) Field observations.
 - 14) Status of RFIs.
 - 15) Status of proposal requests.
 - 16) Pending changes.
 - 17) Status of Change Orders.
 - 18) Pending claims and disputes.
 - 19) Documentation of information for payment requests.
 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Conduct Project coordination meetings at weekly and/or regular intervals. Project 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 Owner, Owner's Commissioning Authority, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site utilization.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Change Orders.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Construction schedule updating reports.
4. Daily construction reports.
5. Material location reports.
6. Site condition reports.
7. Special reports.

- B. Related Requirements:

1. Division 01 Section "Multiple Contract Summary" for preparing a combined Contractor's construction schedule.
2. Division 01 Section "Submittal Procedures" for submitting schedules and reports.
3. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.

- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time [belongs to Owner] [is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date].
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file, where indicated.
 - 2. PDF electronic file.
- B. Startup construction schedule.
 - 1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from **[commencement of the Work] [the Notice to Proceed]** until most recent Application for Payment.

- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit at weekly intervals.
- H. Material Location Reports: Submit at weekly intervals.
- I. Site Condition Reports: Submit at time of discovery of differing conditions.
- J. Special Reports: Submit at time of unusual event.
- K. Qualification Data: For scheduling consultant.

1.5 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including **[phasing] [work stages] [area separations] [interim milestones] [and] [partial Owner occupancy]**.
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review schedule for work of Owner's separate contracts.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures[, **including commissioning activities**].
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's construction schedule with the schedule of values, **[list of subcontracts]**, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - a. **<Elevator Cab / Store Front Window Systems**
 3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 4. Startup and Testing Time: Include no fewer than [15] days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 6. Punch List and Final Completion: Include not more than 45 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01 Section "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 6. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.

- h. Environmental control.
7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
- a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
- a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, temporary enclosure, space conditioning, Substantial Completion, and final completion[.][, **and the following interim milestones:**]
- 1. Temporary enclosure and space conditioning.
 - 2. Completed rough in of systems
- E. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
- 1. See Division 01 Section "Payment Procedures" for cost reporting and payment procedures.
- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
- 1. Unresolved issues.
 - 2. Unanswered Requests for Information (RFI).
 - 3. Rejected or unreturned submittals.
 - 4. Notations on returned submittals.
 - 5. Pending modifications affecting the Work and Contract Time.
- G. Recovery Schedule: When periodic update indicates the Work is [14] <Insert number> or more calendar days behind the current approved schedule, submit a separate recovery

schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

- H. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
 - 1. Use **[Microsoft Project,] [Primavera,] [Meridian Prolog,] [Pro-Core] [Scheduling component of Project Web site software specified in Division 01 Section "Project Management and Coordination,"]**

2.2 STARTUP CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Submit startup, horizontal, bar-chart-type construction schedule within (7) seven days of date established for commencement of the Work.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for the Notice to Proceed. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
 - 1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

2.4 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Startup Network Diagram: Submit diagram within 14 days of date established for the Notice of Award. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.
- C. CPM Schedule: Prepare Contractor's construction schedule using a cost- and resource-loaded, time-scaled CPM network analysis diagram for the Work.
 - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for the Notice to Proceed.

- a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and commissioning.
 - j. Punch list and final completion.
 - k. Activities occurring following final completion.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
 5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project record documents, **[LEED documentation]**, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 - a. Each activity cost shall reflect an appropriate value subject to approval by Architect.
 - b. Total cost assigned to activities shall equal the total Contract Sum.

- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts [**one week**] <Insert time> before each regularly scheduled progress meeting.

2.5 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.

4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (see special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.6 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

2.7 RECORD DOCUMENTS

- A. Prior to the start of construction, the Architect shall deliver to the Contractor, a complete set of "Issued for Construction" drawings, and a complete project manual, including addenda, for the purpose of maintaining record documents.
- B. Also, maintain a copy of all modifications and change orders.

- C. Maintain the documents in a safe, dry location during the entire construction process. The Contractor, together with his sub-contractors, shall indicate clearly and accurately, any and all changes necessitated by field conditions. In addition, accurately maintain dimensions locating all pipes, ducts, etc. built into or under concrete slabs or masonry walls, including elevations, inverts, etc.
- D. With each monthly requisition, send certification, signed by the Contractor's Superintendent and Owner's Field Representative, that the documents are being maintained accurately and currently. At the completion of the Project, return the documents to the Architect, along with certification that the documents are complete in that they represent the true constructed conditions.
- E. Electronic Submission of Record Drawings in AutoCAD is mandatory in addition to hard copies.

2.8 ELECTRONIC FILES

- A. The Robinson Green Beretta Corporation shall make electronic drawing files available to the successful Contractor, at a charge of \$250.00 for the purpose of preparing submittals, record drawings, etc in accordance with the following policy:
 - 1. Drawings shall not be e-mailed, but burned to a CD/DVD.
 - 2. Requester must sign an Electronic File Transmittal Form.
 - 3. Copies of documents that may be relied upon by the Contractor are limited to the printed copies (also known as hard copies) that are signed or sealed by the Architect. Files in electronic media format or text, data, graphic or other types that are furnished by the Architect to the Contractor are only for the convenience of the Contractor. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. When transferring documents in electronic media format, the Architect make no representations as to long-term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems or computer hardware differing from those in use by the Architect at the beginning of this project.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
 - 1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
 - 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- C. Distribution: Distribute copies of approved schedule to Architect, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

01 33 00 – SUBMITTAL PROCEDURES**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Submittal procedures.
- B. Site superintendent.
- C. Construction progress schedules.
- D. Subcontractor list.
- E. Proposed products list.
- F. Product data.
- G. Shop drawings.
- H. Samples.
- I. Test reports.
- J. Design Data.
- K. Certificates.
- L. Manufacturer's instructions.
- M. Manufacturer's field reports.
- N. Erection drawings.

1.2 SUBMITTAL PROCEDURES

- A. Per General Conditions §3.10.2, a Submittal Schedule (Log) shall be submitted. To ensure timely execution of the work, Contractor is encouraged to submit the Submittal Schedule for review within seven (7) calendar days of issuance of the Purchase Order. The Submittal Log shall list all required submittals, organized by division and section, with a proposed date for each item to be submitted. This shall coordinate with the construction schedule.
 - 1. As the project progresses, update the Submittal Log with the date submittal was sent, days since submittal was sent, status of submittal, date submittal was received in return, and any date associated with resubmittals.
 - 2. Update the Submittal Log with each submission and response.
 - 3. Issue copy of the updated Submittal Log electronically with each Application for Payment or upon request by the User Agency.
- B. Preparation and transmission of submittals:
 - 1. Identify all variations from the Contract Documents and any Product or system limitations which may be detrimental to a successful performance of the completed Work.
 - 2. Allow space on the submittals for the Contractor's, Design Agent's, and Consultant's electronic review stamps.
 - 3. Transmit each submittal with a dated Design Agent-accepted transmittal form.
 - 4. Sequentially number the transmittal form. Mark revised submittals with an original number and a sequential alphabetic suffix.

5. Identify the Project, Contractor, subcontractor and supplier; the pertinent drawing and detail number, and the specification Section number, appropriate to the submittal.
 6. Apply a Contractor's electronic stamp certifying that the review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of the information is in accordance with the requirements of the Work and the Contract Documents.
 7. Transmit printed copies and electronic PDF copy of each submittal to the Design Agent for review and comment as outlined in Section.
- C. Submittal Review & Resubmission
1. For each submittal, allow fifteen (15) calendar days for review.
 2. When revised for resubmission, identify the changes made since the previous submission.
 3. Distribute copies of the reviewed submittals as appropriate. Reproduce as necessary to inform subcontractors without internet download capabilities. Instruct the parties to promptly report any inability to comply with the Contract requirements.
 4. Produce additional copies as required for the Record Document purposes as described in Section 01 78 00.

1.3 SITE SUPERINTENDENT

- A. Immediately after the issuance of the Purchase Order, Contractor shall submit the name, email, cell phone, resume of the proposed site superintendent for review and approval by the Design Agent and User Agency.
- B. The site superintendent shall be familiar with the drawings and specifications.
- C. No substitution or replacement of the site superintendent shall be made without notifying the Design Agent and User Agency.

1.4 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial progress schedule in duplicate within ten (10) days of issuance of Purchase Order for Design Agent and User Agency. Upon receipt of reviewed comments, Contractor to submit detailed schedules within five (5) days.
- B. Distribute copies of the reviewed schedules to the Project site file, subcontractors, suppliers, and other concerned parties. Instruct the recipients to promptly report, in writing, the problems anticipated by the projections indicated in the schedules
- C. Submit updated schedules with each Application for Payment, identifying changes since previous version as follows:
 1. Indicate the progress of each activity to the date of submittal, and the projected completion date of each activity.
 2. Identify the activities modified since the previous submittal, major changes in the scope, and other identifiable changes.
 3. Provide a narrative report to define the problem areas, the anticipated delays, and impact on the Schedule. Report the corrective action taken, or proposed, and its effect including the effect of changes on the schedules of separate contractors.
- D. Submit a computer-generated horizontal bar chart with separate line for each major portion of the Work or operation, identifying the first work day of each week.

- E. Show a complete sequence of construction by activity, identifying the Work of separate stages and other logically grouped activities. Indicate the early and late start, the early and late finish, float dates, and duration. Critical path items shall be clearly identified.
- F. Indicate an estimated percentage of completion for each item of the Work at each submission.
- G. Provide a separate schedule of submittal dates for shop drawings, product data, and samples, including User Agency-furnished Products and Products identified under Allowances, if any, and the dates reviewed submittals will be required from the Design Agent. Indicate the decision dates for selection of the finishes.
- H. Indicate the delivery dates for User Agency furnished Products, and for Products identified under Allowances.

1.5 SUBCONTRACTOR LIST

- A. Provide subcontractor list per General Conditions §5.2.1. For each subcontractor, provide contact name, phone number, trade and email. Indicate the SOV line item(s) for which the subcontractor will be providing and if labor will be provided.

1.6 PROPOSED PRODUCTS LIST

- A. Within ten (10) days of issuance of Purchase Order, submit a list of major products proposed for use, with the name of the manufacturer, the trade name, and the model number of each product.
- B. For the products specified only by reference standards, give the manufacturer, trade name, model or catalog designation, and reference standards.
- C. With each product listed, indicate the submittal requirements specified to be adhered to, and an indication of relevant "long-lead-time" information, when appropriate.

1.7 PRODUCT DATA

- A. Product Data: Submit to the Design Agent for review for the limited purpose of checking for conformance with the information given and the design concept expressed in the Contract Documents. Provide copies and distribute in accordance with the SUBMITTAL PROCEDURES article and for the record documents purposes described in Section 01 78 00.
- B. Submit one (1) printed copy and one (1) electronic PDF copy for review. The Design Agent will retain the reviewed printed copy for record and return the reviewed electronic PDF copy to the Contractor for distribution.
- C. Mark each copy to identify the applicable products, models, options, and other data. Supplement the manufacturers' standard data to provide the information specific to this Project.
- D. Indicate the product utility and electrical characteristics, the utility connection requirements, and the location of utility outlets for service for functional equipment and appliances.
- E. After a review distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 01 78 00.

1.8 SHOP DRAWINGS

- A. Shop Drawings: Submit to the Design Agent for review for the limited purpose of checking for conformance with the information given and the design concept expressed in the Contract Documents. Produce copies and distribute in accordance with the SUBMITTAL

PROCEDURES article and for the record documents purposes described in Section 01 78 00.

- B. Submit two (2) printed copies and one (1) electronic PDF copy for review. The Design Agent and /or Consultants will retain the reviewed printed copies for record and return the reviewed electronic PDF copy to the Contractor for distribution.
- C. Indicate the special utility and electrical characteristics, the utility connection requirements, and the location of utility outlets for service for functional equipment and appliances.

1.9 SAMPLES

- A. Samples: Submit to the Design Agent for review for the limited purpose of checking for conformance with the information given and the design concept expressed in the Contract Documents. Produce duplicates and distribute in accordance with the SUBMITTAL PROCEDURES article and for the record documents purposes described in Section 01 78 00.
- B. Samples for Selection as Specified in Product Sections:
 - 1. Submit to the Design Agent for aesthetic, color, or finish selection.
 - 2. Submit samples of the finishes in the colors selected for the Design Agent's records.
 - 3. After review, produce duplicates and distribute in accordance with the SUBMITTAL PROCEDURES article and for the record documents purposes described in Section 01 78 00.
- C. Submit samples to illustrate the functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate the sample submittals for interfacing Work.
- D. Include identification on each sample, with the full Project information.
- E. Submit at least the number of samples specified in the individual specification Sections; the Design Agent will retain two samples.
- F. Reviewed samples, which may be used in the Work, are indicated in the individual specification Sections.
- G. Samples will not be used for testing purposes unless they are specifically stated to be in the specification Section.

1.10 TEST REPORTS

- A. Submit (1) printed and (1) electronic PDF lab reports in accordance with Section 01 40 00.
- B. Submit test reports for information for the limited purpose of assessing conformance with the information given and the design concept expressed in the Contract Documents.

1.11 DESIGN DATA

- A. Submit (1) printed and (1) electronic PDF data for the Design Agent's knowledge as contract administrator for the User Agency.
- B. Submit information for the limited purpose of assessing conformance with the information given and the design concept expressed in the Contract Documents.

1.12 CERTIFICATES

- A. When specified in the individual specification Sections, submit (1) printed and (1) electronic PDF certification by the manufacturer, installation/application subcontractor, or the Contractor to the Design Agent in the quantities specified for the Product Data.
- B. Indicate that the material or product conforms to or exceeds the specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on the material or product, but must be acceptable to the Design Agent and its Consultants.

1.13 MANUFACTURER'S INSTRUCTIONS

- A. When specified in the individual specification Sections, submit (1) printed and (1) electronic PDF copy of instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to the Design Agent for delivery to the User Agency in the quantities specified for Product Data.
- B. Indicate the special procedures, and the perimeter conditions requiring special attention, and the special environmental criteria required for application or installation.

1.14 MANUFACTURER'S FIELD REPORTS

- A. Submit (1) printed and (1) electronic PDF of reports for the Design Agent's benefit as contract administrator for the User Agency.
- B. Submit the report within 30 days of observation to the Design Agent for the limited purpose of assessing conformance with the information given and the design concept expressed in the Contract Documents.

1.15 ERECTION DRAWINGS

- A. When specified in the individual Specification sections, the trade contractors shall submit (1) printed and (1) electronic PDF copy of erection drawings for review prior to proceeding with fabrication and/or construction.
- B. Erection drawings shall be prepared in accordance with the latest edition of the respective trades' codes of standard practice.
- C. All erection drawings shall be fully developed by the trade contractors or by agents of the contractors. CAD files, photocopies, or other reproductions of the contract drawings in whole or in part shall not be used by the trade contractors or their agents for the preparation and development of erection drawings without the expressed written consent of the Design Agent.

1.16 SUBMITTAL LIST

- A. All materials to be installed .
- B. All clarifications required per repetitive division section.
- C. All warranty information
- D. All manufacturer installation requirements

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 40 00 – QUALITY REQUIREMENTS**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Quality control and control of installation.
- B. Contractor Qualifications
- C. Verification of Credentials and Licenses.
- D. Tolerances
- E. References.
- F. Testing and inspection services.
- G. Manufacturers' field services.
- H. Mock-up Requirements.
- I. Testing and Balancing.
- J. Repair of Defective Construction

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor a quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of the specified quality.
- B. Comply with all manufacturers' instructions and recommendations, including each step in sequence.
- C. When the manufacturers' instructions conflict with the Contract Documents, request a clarification from the Design Agent before proceeding.
- D. Comply with the specified standards as a minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform the Work by persons qualified to produce the required and specified quality.
- F. Verify that field measurements are as indicated on the Shop Drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.3 VERIFICATION OF CREDENTIALS AND LICENSES

- A. The User Agency has implemented a project management oversight process and is applying it to current construction projects at RIC.
- B. An element of this oversight process is the verification that persons employed on the project site have appropriate and current credentials and licenses in their possession, at the project site, for the work they are performing.
- C. Be forewarned that state resident inspectors will be checking for verification of credentials and licenses of both union and non-union persons, in their onsite inspections.

- D. State resident inspectors will also be reviewing Contractor's Certified Monthly Payroll Records for conformance with RI State Prevailing Wage Rate requirements.
- E. Those persons without the appropriate credentials and licenses will be subject to dismissal from the project site.

1.4 TOLERANCES

- A. Monitor the fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with the manufacturers' tolerances. When the manufacturers' tolerances conflict with the Contract Documents, request a clarification from the Design Agent before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.5 REFERENCES

- A. For products or workmanship specified by association, trade, or other consensus standard, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by the date of issue current on the date of the Contract Documents, except where a specific date is established by code.
- C. Obtain copies of the standards where required by the product specification Sections.
- D. When the specified reference standards conflict with the Contract Documents, request a clarification from the Design Agent before proceeding.
- E. Neither the contractual relationships, duties, nor responsibilities of the parties in the Contract, nor those of the Design Agent, shall be altered from the Contract Documents by mention or inference otherwise in reference documents.

1.6 TESTING AND INSPECTION SERVICES

- A. The Contractor will submit the name of an independent firm to the Design Agent for approval by the User Agency, to perform the testing and inspection services.
 - 1. Base Bid Testing Requirements List. The Contractor shall pay for all the services required in the Base Bid as described:
 - a. Rebar, Concrete, Masonry, and Steel.
 - 2. Additional User Agency-Authorized Testing Requirements List Contractor shall coordinate any User Agency-authorized additional testing also described to be paid for from Testing Allowance:
 - a. (Insert list of testing which may be authorized beyond the Base Bid work.)
 - b. (Insert other requirements.)
- B. The independent firm will perform the tests, inspections and other services specified in the individual specification Sections and as required by the Design Agent or its Consultants.
 - 1. Laboratory: Authorized to operate in the location in which the Project is located.
 - 2. Laboratory Staff: Maintain a full-time registered Engineer on staff to review the services.
 - 3. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to either the National Bureau of Standards or to the accepted values of natural physical constants.

- C. Testing, inspections and source quality control may occur on or off the project site. Perform off-site testing as required by the Design Agent or the User Agency.
- D. Reports will be submitted by the independent firm to the Design Agent, the Consultant for that trade, and the Contractor, in duplicate, indicating the observations and results of tests and indicating the compliance or non-compliance with Contract Documents.
- E. Cooperate with the independent firm; furnish samples of the materials, design mix, equipment, tools, storage, safe access, and the assistance by incidental labor as requested.
 - 1. Notify the Design Agent and Engineer and the independent firm 24 hours prior to the expected time for operations requiring services.
 - 2. Make arrangements with the independent firm and pay for additional samples and tests required for the Contractor's use.
- F. Testing and employment of the testing agency or laboratory shall not relieve the Contractor of an obligation to perform the Work in accordance with the requirements of the Contract Documents.
- G. Re-testing or re-inspection required because of a non-conformance to the specified requirements shall be performed by the same independent firm on instructions by the Design Agent or its Consultant. Payment for the re-testing or re-inspection will be charged to the Contractor by deducting the testing charges from the Contract Sum.
- H. Agency Responsibilities:
 - 1. Test samples of mixes submitted by the Contractor.
 - 2. Provide qualified personnel at the site. Cooperate with the Design Agent or its Consultant and the Contractor in performance of services.
 - 3. Perform specified sampling and testing of the products in accordance with the specified standards.
 - 4. Ascertain compliance of the materials and mixes with the requirements of the Contract Documents.
 - 5. Promptly notify the Design Agent, Consultant and the Contractor of observed irregularities or non-conformance of the Work or products.
 - 6. Perform additional tests required by the Design Agent or its Consultants.
 - 7. Attend the preconstruction meetings and the progress meetings.
- I. Agency Reports: After each test, promptly submit two copies of the report to the Design Agent, appropriate Consultant, and to the Contractor. When requested by the Design Agent, provide an interpretation of the test results. Include the following:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Name of inspector.
 - 4. Date and time of sampling or inspection.
 - 5. Identification of product and specifications section.
 - 6. Location in the Project.
 - 7. Type of inspection or test.
 - 8. Date of test.
 - 9. Results of tests.

10. Conformance with Contract Documents.

J. Limits On Testing Authority:

1. Agency or laboratory may not release, revoke, alter, or enlarge on the requirements of the Contract Documents.
2. Agency or laboratory may not approve or accept any portion of the Work.

K. Agency or laboratory may not assume any duties of the Contractor.

L. Agency or laboratory has no authority to stop the Work.

1.7 MANUFACTURERS' FIELD SERVICES

- A. When specified in the individual specification Sections, require the material or Product suppliers, or manufacturers, to provide qualified staff personnel to observe the site conditions, the conditions of the surfaces and installation, the quality of workmanship, the start-up of equipment, or test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.
- B. Submit the qualifications of the observer to the Design Agent 30 days in advance of the required observations. Observer is subject to approval of the Design Agent.
- C. Report the observations and the site decisions or instructions given to the applicators or installers that are supplemental or contrary to the manufacturers' written instructions.
- D. Refer to Section 01 33 00 - SUBMITTAL PROCEDURES, MANUFACTURERS' FIELD REPORTS article.

1.8 MOCK-UP REQUIREMENTS

- A. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- B. Accepted mock-ups shall be a comparison standard for the remaining Work.
- C. Where mock-up has been accepted by Architect and is no longer needed, remove mock-up and clear area when directed to do so.

1.9 TESTING, ADJUSTING, AND BALANCING

- A. Submit, for the User Agency's approval, the name of an independent firm to perform testing, adjusting and balancing of systems. The independent firm's services will be paid for by the Contractor.
- B. The independent firm will perform services specified in individual specifications Sections.
- C. Reports will be submitted by the independent firm to the Design Agent and the User Agency indicating observations and test results, indicating compliance or non-compliance with specified requirements and with the requirements of the Contract Documents.

1.10 REPAIR OF DEFECTIVE CONSTRUCTION

- A. Refer to General Conditions §12. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION (NOT USED)****END OF SECTION**

SECTION 01 42 00 - REFERENCES

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.

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

REFERENCES

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association (The) www.aluminum.org	(703) 358-2960
AABC	Associated Air Balance Council www.aabchq.com	(202) 737-0202
AAMA	www.aamanet.org	
AASHTO	American Association of State Highway and Transportation Officials	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists www.aatcc.org	(919) 549-8141
ABAA	Air Barrier Association of America www.airbarrier.org	(866) 956-5888
ABMA	www.abma-dc.org	
ACI	American Concrete Institute	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AF&PA	www.afandpa.org	(202) 463-2700
AGA	American Gas Association	(202) 824-7000

REFERENCES

AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AHRI	Air-Conditioning, Heating, and Refrigeration Institute, The www.ahrinet.org	(703) 524-8800
AI	www.asphaltinstitute.org	
AIA	American Institute of Architects (The)	(800) 242-3837
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	www.aitc-glulam.org	
ALSC	American Lumber Standard Committee, Incorporated	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	www.aosaseed.com	
APA	APA - The Engineered Wood Association	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(239) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	www.ari.org	
ARMA	Asphalt Roofing Manufacturers Association	(202) 207-0917
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)	

REFERENCES

ASHRAE	www.ashrae.org	(404) 636-8400
ASME	ASME International www.asme.org	(800) 843-2763
ASSE	American Society of Sanitary Engineering	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International)	(610) 832-9500
ATIS	Alliance for Telecommunications Industry Solutions www.atis.org	(202) 628-6380
AWCMA	American Window Covering Manufacturers Association (Now WCMA)	
AWCI	www.awci.org	
AWI	Architectural Woodwork Institute	(571) 323-3636
AWPA	American Wood Protection Association (Formerly: American Wood Preservers' Association)	(205) 733-4077
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
BHMA	www.buildershardware.com	
BIA	Brick Industry Association (The)	(703) 620-0010
BICSI	BICSI, Inc. www.bicsi.org	(800) 242-7405 (813) 979-1991
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International) www.bifma.com	(616) 285-3963
BISSC	Baking Industry Sanitation Standards Committee www.bissc.org	(866) 342-4772
CCC	www.carpetcushion.org	

REFERENCES

CDA	Copper Development Association	(800) 232-3282
CEA	Canadian Electricity Association www.canelect.ca	(613) 230-9263
CEA	Consumer Electronics Association www.ce.org	(866) 858-1555 (703) 907-7600
CFFA	www.chemicalfabricsandfilm.com	
CGA	Compressed Gas Association	(703) 788-2700
CIMA	Cellulose Insulation Manufacturers Association www.cellulose.org	(888) 881-2462 (937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	www.cispi.org	
CLFMI	Chain Link Fence Manufacturers Institute	(301) 596-2583
CPA	Composite Panel Association www.pbmdf.com	(703) 724-1128
CRI	Carpet and Rug Institute (The) www.carpet-rug.com	(800) 882-8846 (706) 278-3176
CRRC	www.coolroofs.org	(510) 485-7175
CRSI	Concrete Reinforcing Steel Institute	(847) 517-1200
CRRC	Cool Roof Rating Council www.coolroofs.org	(866) 465-2523 (510) 485-7175
CSA	Canadian Standards Association www.csa.ca	(800) 463-6727 (416) 747-4000
CSA	(Formerly: IAS - International Approval Services) www.csa-international.org	(416) 747-4000
CSI	www.csinet.org	(703) 684-0300
CSSB	Cedar Shake & Shingle Bureau	(604) 820-7700
CTI	Cooling Technology Institute	(281) 583-4087

REFERENCES

	(Formerly: Cooling Tower Institute)	
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
ECA	Electrical Components Association www.ec-central.org	(703)907-8024
EIA	www.eia.org	
EIMA	EIFS Industry Members Association	(800) 294-3462
EJCDC	Engineers Joint Contract Documents Committee http://content.asce.org/ejcdc/	(703) 295-6000
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	(Electrostatic Discharge Association) www.esda.org	
ETL SEMCO	(Formerly: ITS - Intertek Testing Service NA) www.intertek-etlsemko.com	
FIBA	(The International Basketball Federation) www.fiba.com	
FIVB	(The International Volleyball Federation) www.fivb.ch	
FM Approvals	www.fmglobal.com	
FM Global	FM Global www.fmglobal.com	(401) 275-3000
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council www.fsc.org	49 228 367 66 0
GA	www.gypsum.org	(301) 277-8686

REFERENCES

GANA	Glass Association of North America	(785) 271-0208
GRI	(Part of GSI)	
GS	www.greenseal.org	
GSI	Geosynthetic Institute	(610) 522-8440
HI	Hydronics Institute www.gamanet.org	(908) 464-8200
HI/GAMA	Hydronics Institute/Gas Appliance Manufacturers Association Division of Air-Conditioning, Heating, and Refrigeration Institute (AHRI) www.ahrinet.org	(908) 464-8200
HMMA	Hollow Metal Manufacturers Association (Part of NAAMM)	
HPVA	www.hpva.org	
HPW	H. P. White Laboratory, Inc.	(410) 838-6550
IAPSC	International Association of Professional Security Consultants www.iapsc.org	(515) 282-8192
ICBO	International Conference of Building Officials www.iccsafe.org	(888) 422-7233
ICEA	www.icea.net	
ICRI	International Concrete Repair Institute, Inc.	(847) 827-0830
ICPA	International Cast Polymer Association www.icpa-hq.org	(703) 525-0320
IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	www.ieee.org	
IES	Illuminating Engineering Society of North America	(703) 525-0320
IEST	Institute of Environmental Sciences and Technology www.iest.org	(847) 255-1561

REFERENCES

IGMA	Insulating Glass Manufacturers Alliance www.igmaonline.org	(613) 233-1510
ILI	www.iliai.com	
ISA	Instrumentation, Systems, and Automation Society, The	(919) 549-8411
ISO	International Organization for Standardization www.iso.ch	41 22 749 01 11
ISSFA	International Solid Surface Fabricators Association www.issfa.net	(877) 464-7732 (801) 341-7360
ITS	(Now ETL SEMCO)	
ITU	International Telecommunication Union	41 22 730 51 11
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LGSEA	Light Gauge Steel Engineers Association www.arcat.com	(202) 263-4488
LMA	(Now part of CPA)	
LPI	Lightning Protection Institute	(800) 488-6864
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MCA	Metal Construction Association www.metalconstruction.org	(847) 375-4718
MFMA	www.maplefloor.org	
MFMA	Metal Framing Manufacturers Association, Inc.	(312) 644-6610
MH	Material Handling (Now MHIA)	
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	www.marble-institute.com	
MPI	Master Painters Institute	(888) 674-8937

REFERENCES

MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(630) 942-6591
NACE	(National Association of Corrosion Engineers International) www.nace.org	(281) 228-6200
NADCA	www.nadca.com	
NAGWS	National Association for Girls and Women in Sport	(800) 213-7193, ext. 453
NAIMA	North American Insulation Manufacturers Association www.naima.org	(703) 684-0084
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848
NCAA	www.ncaa.org	
NCMA	National Concrete Masonry Association	(703) 713-1900
NCTA	National Cable & Telecommunications Association www.ncta.com	(202) 222-2300
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	www.necanet.org	
NeLMA	Northeastern Lumber Manufacturers' Association	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(888) 300-6382 (269) 488-6382
NFHS	www.nfhs.org	
NFPA	NFPA www.nfpa.org	(800) 344-3555

REFERENCES

NFRC	National Fenestration Rating Council	(301) 589-1776
NGA	National Glass Association www.glass.org	(866) 342-5642 (703) 442-4890
NHLA	National Hardwood Lumber Association www.natlhardwood.org	(800) 933-0318 (901) 377-1818
NLGA	www.nlga.org	
NOFMA	NOFMA: The Wood Flooring Manufacturers Association www.nofma.org	(901) 526-5016
NOMMA	National Ornamental & Miscellaneous Metals Association	(888) 516-8585
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSF	(National Sanitation Foundation International) www.nsf.org	(734) 769-8010
NSSGA	www.nssga.org	(703) 525-8788
NTMA	National Terrazzo & Mosaic Association, Inc. (The)	(800) 323-9736
NWFA	National Wood Flooring Association www.nwfa.org	(800) 422-4556 (636) 519-9663
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDI	www.pdionline.org	(978) 557-0720
PGI	PVC Geomembrane Institute	(217) 333-3929
PTI	Post-Tensioning Institute www.post-tensioning.org	(248) 848-3180
RCSC	Research Council on Structural Connections www.boltcouncil.org	
RFCI	www.rfci.com	(706) 882-3833

REFERENCES

RIS	Redwood Inspection Service	
SAE	SAE International www.sae.org	(877) 606-7323 (724) 776-4841
SCAQMD	South Coast Air Quality Management District www.aqmd.com	(909) 396-2000
SCTE	www.scte.org	(610) 363-6888
SDI	Steel Deck Institute	(847) 458-4647
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010
SEFA	Scientific Equipment and Furniture Association www.sefalabs.com	(877) 294-5424 (516) 294-5424
SEI/ASCE	(See ASCE)	
SIA	Security Industry Association	(866) 817-8888
SJI	Steel Joist Institute www.steeljoist.org	(843) 626-1995
SMA	Screen Manufacturers Association www.smacentral.org	(561) 533-0991
SMACNA	National Association www.smacna.org	
SMPTE	www.smpte.org	
SPFA	Spray Polyurethane Foam Alliance www.sprayfoam.org	(800) 523-6154
SPIB	Southern Pine Inspection Bureau (The)	(850) 434-2611
SPRI	Single Ply Roofing Industry www.spri.org	(781) 647-7026
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSPC	www.sspc.org	(412) 281-2331

REFERENCES

STI	Steel Tank Institute	(847) 438-8265
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333
SWPA	Submersible Wastewater Pump Association www.swpa.org	(847) 681-1868
TCA	www.tilt-up.org	
TCNA	Tile Council of North America, Inc.	(864) 646-8453
TEMA	Tubular Exchanger Manufacturers Association www.tema.org	(914) 332-0040
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance www.tiaonline.org	(703) 907-7700
TMS	www.masonrysociety.org	
TPI	Truss Plate Institute, Inc.	(703) 683-1010
TPI	Turfgrass Producers International www.turfgrassod.org	(800) 405-8873 (847) 649-5555
TRI	Tile Roofing Institute www.tilerroofing.org	(312) 670-4177
UL	www.ul.com	(847) 272-8800
UNI	Uni-Bell PVC Pipe Association	(972) 243-3902
USAV	USA Volleyball www.usavolleyball.org	(888) 786-5539 (719) 228-6800
USGBC	U.S. Green Building Council www.usgbc.org	(800) 795-1747
USITT	www.usitt.org	(315) 463-6463
WASTEC	Waste Equipment Technology Association	(800) 424-2869
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association	(212) 297-2122

REFERENCES

	www.wcmanet.org	
WDMA	(Formerly: NWWDA - National Wood Window and Door Association) www.wdma.com	(312) 321-6802
WI	www.wicnet.org	
WMMPA	Wood Moulding & Millwork Producers Association	(800) 550-7889
WSRCA	Western States Roofing Contractors Association www.wsrca.com	(800) 725-0333 (650) 570-5441
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930

- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

DIN	www.din.de	
IAPMO	International Association of Plumbing and Mechanical Officials	(909) 472-4100
ICC	International Code Council www.iccsafe.org	(888) 422-7233
ICC-ES	ICC Evaluation Service, Inc. www.icc-es.org	(800) 423-6587 (562) 699-0543

- D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

COE	Army Corps of Engineers www.usace.army.mil	
CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-7923
DOC	Department of Commerce www.commerce.gov	(202) 482-2000
DOD	Department of Defense http://dodssp.daps.dla.mil	(215) 697-6257
DOE	Department of Energy www.energy.gov	(202) 586-9220

REFERENCES

EPA	Environmental Protection Agency	(202) 272-0167
FAA	Federal Aviation Administration www.faa.gov	(866) 835-5322
FCC	Federal Communications Commission www.fcc.gov	(888) 225-5322
FDA	www.fda.gov	
GSA	General Services Administration	(800) 488-3111
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
LBL	Lawrence Berkeley National Laboratory www.lbl.gov	(510) 486-4000
NCHRP	(See TRB)	
NIST	National Institute of Standards and Technology	(301) 975-6478
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742 (202) 693-1999
PBS	Public Buildings Service (See GSA)	
PHS	http://www.hhs.gov/ophs/	
RUS	Rural Utilities Service	(202) 720-9540
SD	State Department www.state.gov	(202) 647-4000
TRB	Transportation Research Board http://gulliver.trb.org	(202) 334-2934
USDA	www.usda.gov	
USP	U.S. Pharmacopeia	(800) 227-8772
USPS	Postal Service www.usps.com	(202) 268-2000

REFERENCES

- E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

ADAAG	Americans with Disabilities Act (ADA) Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities Available from U.S. Access Board www.access-board.gov	(202) 272-0080
CFR	Code of Federal Regulations Available from Government Printing Office www.gpoaccess.gov/cfr/index.html	(866) 512-1800 (202) 512-1800
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	(215) 697-2664
DSCC	Defense Supply Center Columbus (See FS)	
FED-STD	Federal Standard (See FS)	
FS	Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil/ www.dsp.dla.mil Available from General Services Administration	(202) 619-8925
	Available from National Institute of Building Sciences www.wbdg.org/ccb	(202) 289-7800
FTMS	Federal Test Method Standard (See FS)	
MIL		
MIL-STD	(See MILSPEC)	
MILSPEC	Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	
UFAS	Available from Access Board www.access-board.gov	(202) 272-0080

- F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following

REFERENCES

list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CBHF	www.dca.ca.gov/bhfti	(916) 574-2041
CCR	California Code of Regulations	(916) 323-6815
CDHS	California Department of Health Services www.dhcs.ca.gov	(916) 445-4171
CDPH	California Department of Public Health, Indoor Air Quality Section www.cal-iaq.org	
CPUC	www.cpuc.ca.gov	
TFS	Texas Forest Service http://txforestservation.tamu.edu	

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

Program of Special Inspections

RGB# 6831

Project: **Rhode Island College Adams Library Elevator Addition**

Location: **600 Mount Pleasant Ave, Providence, RI**

Owner: **State of Rhode Island**

Owner's Address:

Architect of Record: **The Robinson Green Beretta Corporation**

Structural Engineer of Record: **Structures Engineering and Design LLC**

Mechanical Engineer of Record:

This **Program of Special Inspections** is submitted as a condition for permit issuance in accordance with the Special Inspection requirements of Chapter 17 of the Rhode Island State Building Code. It includes an outline Schedule for Special Inspection Services applicable to the Rhode Island College Adams Library Elevator Addition as well as the name of the Special Inspector and the identity of other approved agencies intended to be retained for conducting these inspections.

The Special Inspector shall keep records of all inspections and shall furnish inspection reports to the Building Official, Architect of Record, Structural Engineer and other system design engineers as indicated.

Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected or corrective action begun with three days, the discrepancies shall be brought to the attention of the Structural Engineer and Architect of Record. If such discrepancies are not corrected or corrective action begun with three days, the discrepancies shall be brought to the attention of the Building Official.

The Special Inspection Program does not relieve the Contractor of his or her responsibilities.

Interim reports shall be submitted to the Building Official, Owner, Architect of Record, Structural Engineer, and other system design engineers as indicated.

A *Final Report of Special Inspections* documenting completion of all required Special Inspections and correction of any discrepancies noted in the inspections shall be submitted prior to issuance of a Certificate of Use and Occupancy.

Job site safety and means and methods of construction are solely the responsibility of the Contractor.

Interim Report Frequency: **Monthly**

or per attached schedule.

Prepared by:

Jeremy J. Page

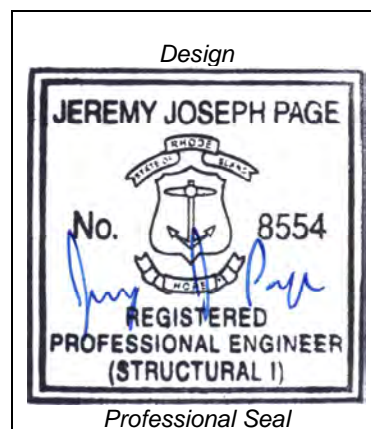
(type or print name)



Signature

7-9-2024

Date



Owner's Authorization:

Building Official's Acceptance:

Signature

Date

RIC Adams Library Elevator Addition - 6831

Signature

Date

Page 1 of 13

Program of Special Inspection Services

Project:

Schedule for the Program of Special Inspection Services

The following sheets comprise the required schedule of special inspections for this project. The construction divisions which require special inspections for this project are as follows:

- X Soils and Foundations
- X Cast-in-Place Concrete
- Precast Concrete
- X Masonry
- X Structural Steel
- Cold-Formed Steel Framing
- Spray Fire Resistant Material
- Wood Construction
- Exterior Insulation and Finish System
- Mechanical & Electrical Systems
- Architectural Systems
- Special Cases

Inspection Agents	Firm	Address
1. Special Inspection Coordinator		
2. Special Inspector		
3. Inspector		
4. Testing Laboratory		
5. Testing Laboratory		
6. Other Architect of Record: A &/or Architect's Representative: AR	The Robinson Green Beretta Corporation	50 Holden Street Providence, RI, 02908 401 272 1730

Note: The inspection and testing agent shall be engaged by the Owner or the Owner's Agent, and not by the Contractor or Subcontractor whose work is to be inspected or tested. Any conflict of interest must be disclosed to the Building Official, prior to commencing work.

Relevant RISBC Design Notations:

Occupancy Category: Table 1604.5
 Seismic Design Category: IBC Section 1613.2.5
 Basic Wind Speed:
 Wind Exposure Category:

Risk Category III
Category B
138 mph
Exposure B

❖ Therefore the project requires from 1705.11 Special inspection for wind resistance

Quality Assurance Plan

Quality Assurance for Wind Requirements

Basic Wind Speed (3 second gust)	138 mph
Wind Exposure Category	Exposure B
Quality Assurance Plan Required (Y/N)	yes

Description of wind force resisting system and designated wind resisting components:

Reinforced masonry shear walls, concrete floor diaphragms, metal deck roof diaphragm

Statement of Responsibility

Each contractor responsible for the construction or fabrication of a system or component designated above must submit a Statement of Responsibility (Reference RISBC Section 1706) when either Seismic (1705.3) &/or Wind (1705.4) Special Inspections are required..

Qualifications of Inspectors and Testing Technicians

The qualifications of all personnel performing Special Inspection activities are subject to the approval of the Building Official. The credentials of all Inspectors and testing technicians shall be provided if requested.

The Design Professionals in Responsible Control recommend that the person administering the Program of Special Inspections program be an Architect, Structural Engineer or a Professional Engineer with 10 years minimum experienced in the design of buildings as an Architect or Engineer of Record.

Key for Minimum Qualifications of Special Inspection Agents:

When the Program of Special Inspection Design Professional in Responsible Control deems it appropriate that the individual performing a stipulated test or inspection have a specific certification or license as indicated below, such designation shall appear below the *Agent Number* on the *Program of Special Inspections*.

- A Architect of Record, or Architect**– a licensed Architect involved in the design of this project component

- AR Architect's Representative-** Experienced Architectural Field Representative with ten years minimum experience in observing and/or monitoring construction projects of a similar nature and as approved by the Architect of Record as an adequately qualified field representative.
- SE Structural Engineer** – a licensed SE or PE specializing in the design of building structures. This may be required for the inspection of critical structural elements.
- PE Professional Engineer** – a licensed PE specializing in the design of certain building systems. This may be required for the inspection of critical mechanical, electrical, plumbing, &/or fire protection elements &/or assemblies.
- GE Geotechnical Engineer** – a licensed PE specializing in soil mechanics and foundations. This may be required for the inspection of difficult soil conditions or deep foundations.
- EIT Engineer-In-Training** – a graduate engineer who has passed the Fundamentals of Engineering examination. This may be required for the inspection of elements that require some engineering training to properly evaluate.
- ACI American Concrete Institute - Level I Certified Concrete Field Testing Technician.** This certification is appropriate for individuals performing concrete sampling, slump tests, air-content tests, temperature tests, unit weight tests, and casting compression test cylinders.
- AWS American Welding Society - Certified Welding Inspector (CWI).** This certification is appropriate for individuals performing visual inspection of welds.
- ASNT American Society of Non-Destructive Testing** – Level II or III. This certification is appropriate for individuals performing ultra-sonic testing of welds.
- SMSI Structural Masonry Special Inspector** – certification by ICBO.
- SWSI Structural Steel and Welding Special Inspector** – certification by ICBO.
- SFSI Spray-Applied Fireproofing Special Inspector** – certification by ICBO.
- PCSI Prestressed Concrete Special Inspector** – certification jointly sponsored by ICBO, BOCA and SBCCI with participation from PCI and PTI.
- RCSI Reinforced Concrete Special Inspector** – certification jointly sponsored by ACI, ICBO, BOCA and SBCCI.
- SCSI Smoke Control System Special Inspector**– Licensed PE with expertise in smoke control system design, fire protection engineering, mechanical engineering and/or other individuals with similar experience and a 5 years minimum inspection experience as a certified air balancer.

American Concrete Institute (ACI) Certification

ACI-CFTT	Concrete Field Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector
ACI-LTT	Laboratory Testing Technician – Grade 1&2
ACI-STT	Strength Testing Technician

American Welding Society (AWS) Certification

AWS-CWI	Certified Welding Inspector
AWS/AISC-SSI	Certified Structural Steel Inspector

American Society of Non-Destructive Testing (ASNT) Certification

ASNT	Non-Destructive Testing Technician – Level II or III.
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International Code Council (ICC) Certification

ICC-SMSI Structural Masonry Special Inspector
ICC-SWSI Structural Steel and Welding Special Inspector
ICC-SFSI Spray-Applied Fireproofing Special Inspector
ICC-PCSI Prestressed Concrete Special Inspector
ICC-RCSI Reinforced Concrete Special Inspector

National Institute for Certification in Engineering Technologies (NICET)

NICET-CT Concrete Technician – Levels I, II, III & IV
NICET-ST Soils Technician - Levels I, II, III & IV
NICET-GET Geotechnical Engineering Technician - Levels I, II, III & IV

Exterior Design Institute (EDI) Certification

EDI-EIFS EIFS Third Party Inspector

Other

Soils and Foundations

Item	Agency # (Qualif.)	Scope
1. Shallow Foundations	PE/GE/ EIT/ NICET-ST	<p><i>Inspect soils below footings for adequate bearing capacity and consistency with geotechnical report.</i></p> <p><i>Inspect removal of unsuitable material and preparation of subgrade prior to placement of controlled fill</i></p> <p><i>Verify excavations are extended to proper depth and have reached proper material</i></p>
2. Controlled Structural Fill	PE/GE/ EIT/ NICET-ST	<p><i>Perform sieve tests (ASTM D422 & D1140) and modified Proctor tests (ASTM D1557) of each source of fill material.</i></p> <p><i>Inspect placement, lift thickness, compaction, and use of proper materials of controlled fill.</i></p> <p><i>Test density of each lift of fill by nuclear methods (ASTM D2922)</i></p> <p><i>Verify extent and slope of fill placement.</i></p>
4. Load Testing	PE/GE/ EIT/ NICET-ST	<p><i>Inspection of soil compaction</i></p>

Cast-in-Place Concrete

Item	Agency # (Qualif.)	Scope
1. Mix Design	ACI-CCI ICC-RCSI	Review concrete batch tickets and verify compliance with approved mix design. Verify that water added at the site does not exceed that allowed by the mix design.
2. Material Certification	ACI-CCT ICC-RCSI GEC	Review certified test reports, verify reports conform to design criteria of contract documents and engineers specifications
3. Reinforcement Installation	ACI-CCI ICC-RCSI	Inspect size, spacing, cover, positioning and grade of reinforcing steel. Verify that reinforcing bars are free of form oil or other deleterious materials. Inspect bar laps and mechanical splices. Verify that bars are adequately tied and supported on chairs or bolsters
6. Anchor Rods	ACI-CCI ICC-RCSI	Inspect size, positioning and embedment of anchor rods. Inspect concrete placement and consolidation around anchors.
7. Concrete Placement	ACI-CCI ICC-RCSI	Inspect placement of concrete. Verify that concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated.
8. Sampling and Testing of Concrete	ACI-CFTT ACI-STT	Test concrete compressive strength (ASTM C31 & C39), slump (ASTM C143), air-content (ASTM C231 or C173) and temperature (ASTM C1064).
9. Curing and Protection	ACI-CCI ICC-RCSI	Inspect curing, cold weather protection and hot weather protection procedures.
10. Post installed anchors	ACI-CCI ICC-RCSI	Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads. Continuous inspection Inspect all other mechanical anchors and adhesive anchors periodically
11. Formwork	ACI-CCI ICC-RCSI	Inspect formwork for shape, location, and dimensions of the concrete member being formed periodically

Masonry

ACI 531, Section 1.19

Item	Agent	Scope	Frequency
Prior to Construction			
Review material certificates, mix designs, test results and construction procedures	PE/SE/ EIT/ ICC-SMSI	Verify that materials conform to the requirements of the approved construction documents. Mix design, test results, material certificates, and construction procedures should be submitted for review. Mortar mix designs shall conform to ASTM C 270 while grout shall conform to ASTM C 476. Material certificates shall be provided for the following: reinforcement; anchors, ties, fasteners, and metal accessories; masonry units; mortar and grout materials. Construction procedures for cold-weather or hot-weather construction shall be reviewed.	Periodic
As Construction Begins			
Proportions of site-prepared mortar	PE/SE/ EIT/ ICC-SMSI	Verify that mortar is of the type and color specified on the construction documents, that it conforms to ASTM C 270, and that it is mixed in accordance with Article 2.6 A of TMS-602/ACI 530.1-11.	Periodic
Verify Compliance	PE/SE/ EIT/ ICC-SMSI	Grade, type, and size of reinforcement and anchor bolts, and prestressing tendons and anchorages	Periodic
Placement of masonry units and construction of mortar joints.	PE/SE/ EIT/ ICC-SMSI	Verify that mortar joints comply with Article 3.3 B of TMS-602/ACI 530.1-11.	Periodic
Location of reinforcement, connectors, and anchorages	PE/SE/ EIT/ ICC-SMSI	Verify that reinforcement is placed in accordance with Article 3.4 of TMS-602/ACI 530.1-11. Prestressing tendons shall be placed per Article 3.6 A.	Continuous
Prior to Grouting			
Grout Space	PE/SE/ EIT/ ICC-SMSI	Verify that grout space is free of mortar droppings, debris, loose aggregate, and other deleterious materials and that cleanouts are provided per Article 3.2 D and 3.2 F of TMS-602/ACI 530.1-11. <i>Continuous inspection is required for Risk Category IV buildings.</i>	Continuous
Grade, type, and size of reinforcement and anchor bolts, and anchorages	PE/SE/ EIT/ ICC-SMSI	Verify that reinforcement, joint reinforcement, wall ties, anchor bolts and veneer anchors comply with the approved construction documents and Section 1.6 of TMS 402/ACI 530-11.	Periodic

Placement of reinforcement, connectors, and anchorages	PE/SE/ EIT/ ICC-SMSI	Verify that reinforcement, joint reinforcement, wall ties, anchor bolts and veneer anchors are installed in accordance with the approved construction documents and Articles 3.2 E, 3.4, and 3.6 A of TMS 602/ACI 530.1-11. <i>Continuous inspection is required for Risk Category IV buildings.</i>	Continuous
Proportions of site-prepared grout for bonded tendons	PE/SE/ EIT/ ICC-SMSI	Verify that grout is proportioned per ASTM C 476 and has a slump between 8-11 inches. Self-consolidated grout shall not be proportioned onsite. (see Articles 2.6 B and 2.4 G.1.b of TMS 602/ACI 530.1-11. <i>Continuous inspection is required for Risk Category IV buildings.</i>	Periodic
Construction of mortar joints	PE/SE/ EIT/ ICC-SMSI	Verify that mortar joints are placed in accordance with Article 3.3 B of TMS 602/ACI 530.1-11.	Periodic
During Masonry Construction			
Size and location of structural elements	PE/SE/ EIT/ ICC-SMSI	Verify the locations of structural elements with respect to the approved plans and confirm that tolerances meet the requirements of Article 3.3 F of TMS 602/ACI 530.1-11.	Periodic
Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction.	PE/SE/ EIT/ ICC-SMSI	Verify that correct anchorages and connections are provided per the approved plans and Sections 1.16.4.3 and 1.17.1 of TMS 402/ACI 530-11. <i>Continuous inspection is required for Risk Category III buildings.</i>	Continuous
Welding of reinforcement	PE/SE/ EIT/ ICC-SMSI		Continuous
Preparation, construction, and protection of masonry during cold weather (<40°F) or hot weather (>90°F).	PE/SE/ EIT/ ICC-SMSI	Verify that cold-weather construction is performed in accordance with Article 1.8 C of TMS 602/ACI 530.1-11 and hot weather construction per Article 1.8 D of TMS 602/ACI 530.1-11.	Periodic
Observation of grout specimens, mortar specimens, and/or prisms	PE/SE/ EIT/ ICC-SMSI	Confirm that specimens/prisms are performed as required by Article 1.4 of TMS-602/ACI 530.1-11. <i>Continuous inspection is required for Risk Category IV buildings.</i>	Continuous

Minimum Testing			
Verification of Slump Flow and Visual Stability Index (VSI) for self-consolidating grout	PE/SE/ EIT/ ICC-SMSI	Compressive strength tests should be performed in accordance with ASTM C 1019 for slump flow and ASTM C 1611 for VSI.	Periodic
Verification of f'_m and f'_{AAC}	PE/SE/ EIT/ ICC-SMSI	Determine the compressive strength for each wythe by the "unit strength method" or by the "prism test method" as specified in Article 1.4 B of TMS 602/ACI 530.1-11 prior to construction. <i>This should be verified at every 2,000ft² of construction.</i>	Periodic
Verification of proportions of materials in premixed or pre-blended mortar and grout	PE/SE/ EIT/ ICC-SMSI	Verify that proportions for mortar meet ASTM C 270 and proportions for grout meet ASTM C 476. This applies to <i>Risk Category IV buildings only.</i>	Periodic

Structural Steel

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures	AWS/AIS C-SSI ICC-SWSI	Review shop fabrication and quality control procedures.
2. Material Certification	AWS/AIS C-SSI ICC-SWSI	Review certified mill test reports and identification markings on wide-flange shapes, high-strength bolts, nuts and welding electrodes
4. Bolting	AWS/AIS C-SSI ICC-SWSI	Inspect installation and tightening of high-strength bolts. Verify that splines have separated from tension control bolts. Verify proper tightening sequence. Continuous inspection of bolts in slip-critical connections.
5. Welding	AWS-CWI ASNT	Visually inspect all welds. Inspect pre-heat, post-heat and surface preparation between passes. Verify size and length of fillet welds. Ultrasonic testing of all full-penetration welds.
7. Structural Details	PE/SE	Inspect steel frame for compliance with structural drawings, including bracing, member configuration and connection details.

Instructions – Preparation of the Program of Special Inspections (PoSI)

1. Who Prepares the Form:

The program of inspection and/or testing for a project should be prepared by the Registered Design Professional (RDP) that is in responsible charge of the building system requiring inspections and testing.

- A. The Architect of Record should prepare the corresponding sections of the PoSI for the building systems that they are responsible for. For further explanation, please refer to the “Guide to Special Inspections and Quality Assurance”.
- B. The Structural Engineer of Record (SER) should prepare the sections required for the structural elements such as foundations, concrete, structural steel, etc.
- C. The MEP Engineers of Record should prepare the corresponding sections of the PoSI for the building systems that they are responsible for.
- D. For further explanation, please refer to the “Guide to Special Inspections and Quality Assurance”.

2. The Front Page 1:

- 2-1. At the top of the page indicate the project name and location as they appear on the Contract Documents, provide the Owner’s name (individual, private company, municipality, government agency, etc.), and indicate the Design Professional In Responsible Charge. This should be the RDP in responsible charge of the building systems for which this Program of Special Inspections (PoSI) is being prepared. See explanation in item 1 above.
- 2-2. Next, read the first paragraph and check the box below indicating the discipline(s) that this PoSI will encompass (Structural, Architectural, Mechanical/Electrical/Plumbing, or Other).
- 2-3. After reading the remaining paragraphs, the RDP must indicate the frequency of “Interim Reports” required from the Special Inspection Coordinator for the project. This can be indicated directly on the page, i.e. “weekly”, or the adjacent box can be checked to attach a more specific schedule.
- 2-4. Near the bottom of the page, the RDP must print, sign, and date the form, and stamp the form with their professional seal in the box provided.
- 2-5. The Owner or Owner’s agent must sign and date the front page after the PoSI has been completed by the RDP.
- 2-6. The Building Official must sign and date the form upon acceptance.

3. Page 2 – Schedule of Inspection and Testing Agencies:

- 3-1. The top of the page lists all of the categories of building systems with a box next to each. The RDP must check the boxes for only the building systems that are going to be covered in this PoSI. A completed inspection program page must be attached for each building system that is checked off. (See instruction #5 below.)
- 3-2. The chart below is where the members of the Program of Special Inspection are listed. Their names, addresses, telephone numbers, and emails should be filled out in the appropriate boxes. If the Inspectors and Testing Agencies have not been determined yet, the RDP can fill in the boxes with “To Be Determined”.

4. Page 3 – Quality Assurance Plan:

- 4-1. The RDP must review sections 1705 and 1706 in Chapter 17 of the IBC to determine if the project requires a Quality Assurance Plan for the seismic force and wind force resisting systems and components.
 - 4-2. The RDP must indicate whether or not a Quality Assurance Plan is required by filling in the information requested on the page. It is only necessary to provide descriptions of the seismic and wind force resisting systems if it is determined that a Quality Assurance Plan is required.
5. Inspection Program Pages For Each Building System:
- 5-1. There is a page attached for each building system where the RDP identifies the inspection requirements of each system. Fill out the pages for only the building systems included in this PoSI. Do not include blank pages for building systems not covered under this PoSI.
 - 5-2. Indicate the inspection or testing firm (Agency #) that will perform each inspection task. The Agency # is the number listed next to the Inspector or Testing Laboratory on the chart on page 2 of the SSI.
 - 5-3. Indicate the required qualifications of the Inspector for each inspection. A list of qualifications of Inspectors and testing technicians is provided on page 4 of the PoSI for reference. The RDP may require additional qualifications beyond the ones listed if they feel it is appropriate. Suggested qualifications have been included for consideration. The RDP must determine what qualifications are appropriate for the particular project and confirm that the selected agency employs individuals with the specified qualifications.
 - 5-4. The scope of each inspection must be filled in by the RDP. The editable text provided in italics reflects the code mandated minimum inspection requirements designated in section 1704 of IBC Chapter 17. The editable text does not include the inspections requirements for seismic and wind resisting systems listed in sections 1705 through 1708. The RDP must determine if the project falls under the requirements of sections 1705 to 1708 and add the required inspections to the building systems. The final scope of the inspections required for the project must be determined by the RDP.
 - 5-5. Descriptions of all inspections must include the required frequency of each inspection or test.

01 50 00 – TEMPORARY FACILITIES AND CONTROLS**PART 1 - GENERAL**

1.1 SECTION INCLUDES

A. Temporary Utilities:

1. Temporary electricity.
2. Temporary lighting for construction purposes.
3. Temporary heating.
4. Temporary cooling.
5. Temporary ventilation.
6. Telephone service.
7. Temporary water service.
8. Temporary sanitary facilities.

B. Construction Facilities:

1. Field offices and sheds.
2. Hoisting.
3. Parking/Traffic.
4. Project identification.
5. Traffic regulation.
6. Independent Food Vendors

C. Temporary Controls:

1. Barriers.
2. Enclosures and fencing.
3. Security.
4. Fire detection.
5. Water control.
6. Dust control.
7. Erosion and sediment control.
8. Noise control.
9. Pest and rodent control.
10. Pollution control.

D. Removal of utilities, facilities, and controls with reseeding and repair of grounds.

1.2 TEMPORARY ELECTRICITY

- A. The User Agency will pay the cost of energy used. Exercise measures to conserve energy. Utilize the User Agency's existing power service.
- B. Complement the existing power service capacity and characteristics as required for construction operations.
- C. Provide power outlets, with branch wiring and distribution boxes located at each floor or as required for construction operations. Provide flexible power cords as required for portable construction tools and equipment. All flexible power cords shall be suspended with hangers to eliminate trip hazards.
- D. Provide main service disconnect and over-current protection at a convenient location or a feeder switch at the source distribution equipment or meter.
- E. Permanent convenience receptacles may not be utilized during construction.
- F. Provide distribution equipment, wiring, and outlets to provide single-phase branch circuits for power. Provide 20-ampere duplex outlets, single-phase circuits for power tools.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain incandescent lighting for construction (interior & exterior) operations to achieve a minimum lighting level of 2 watt/sq. ft. (21 watt/sq m).
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pig-tails, and lamps as required.
- C. Maintain lighting and provide routine repairs.
- D. Permanent building lighting may be utilized during construction where not removed.

1.4 TEMPORARY HEATING

- A. Existing facilities will be occupied and heated by the College when temperatures require. Take care to avoid leaving doors open in exterior walls that could compromise heating operations. For new construction, the cost of energy will be borne by the Contractor. Provide temporary heating as necessary for construction operations.
- B. Supplement with temporary heat devices if needed to maintain the specified conditions for construction operations even in existing buildings.
- C. Maintain a minimum ambient temperature of 50 degrees F in the areas where construction is in progress, unless indicated otherwise in the product Sections.
- D. In areas of work with mechanical hot-air heating, clean units and replace filters after Substantial Completion.
- E. Do not use new equipment for heating after replacement during construction.
- F. Provide temporary heating to occupied spaces if construction activities impact normal function of existing systems to occupied spaces. Submit an implementation plan for review and approval by RIC.

1.5 TEMPORARY COOLING

- A. Existing facilities are not available.
- B. Provide and pay for cooling devices and cooling as needed to maintain the specified conditions for construction operations.

- C. Maintain a maximum ambient temperature of 80 degrees F in the areas where construction is in progress, unless indicated otherwise in the specifications.
- D. Provide temporary cooling to occupied spaces if construction activities impact normal function of existing systems to occupied spaces. Submit an implementation plan for review and approval by RIC.

1.6 TEMPORARY VENTILATION

- A. Ventilate the enclosed areas to achieve a curing of materials, to dissipate humidity, and to prevent the accumulation of dust, fumes, vapors, or gases.
- B. If existing ventilation fans are used during construction, clean fans in areas of work after Substantial Completion.
- C. Provide temporary ventilation to occupied spaces if construction activities impact normal function of existing systems to occupied spaces. Submit an implementation plan for review and approval by RIC.

1.7 TELEPHONE SERVICE

- A. Provide, maintain, and pay for cell phone service to the field supervisor at the time of project mobilization.

1.8 TEMPORARY WATER SERVICE

- A. The User Agency will pay the cost of temporary water. Exercise measures to conserve energy. Utilize the User Agency's existing water system, extend and supplement with temporary devices as needed to maintain the specified conditions for construction operations.
- B. Extend branch piping with outlets located so that water is available by hoses with threaded connections. Provide temporary pipe insulation if needed to prevent freezing.

1.9 TEMPORARY SANITARY FACILITIES

- A. Contractor needs to provide and maintain temporary toilet facilities for use by all construction personnel. Trades people will not be permitted to use existing facilities within the building.

1.10 FIELD OFFICES AND SHEDS

- A. Do not use existing facilities for storage. Job meetings will be held on campus at a location to be chosen by the College.
- B. Storage Areas and Sheds: Size to the storage requirements for the products of the individual Sections, allowing for access and orderly provision for the maintenance and for the inspection of Products to the requirements of Section 01 60 00. Containers will be permitted within the project limit line.
- C. Preparation: Fill and grade the sites for the temporary structures to provide drainage away from the buildings.
- D. Removal: At the completion of the Work remove the buildings, foundations, utility services, and debris. Restore the areas.

1.11 HOISTING

- A. Contractor is responsible for all hoisting required to facilitate, serve, stock, clean, and complete the Work. Include all costs for Operating Engineers, fuel, delivery and removal, mobilization, staging, protection of grades and surfaces, and equipment.

1.12 PARKING/TRAFFIC

- A. Workers must park in lots assigned by the College with daily permits. See Site Utilization Plan.
- B. Use of designated existing on-site streets and driveways for construction traffic is permitted. Tracked vehicles are not allowed on paved areas.
- C. Do not allow heavy vehicles or construction equipment in parking areas.
- D. Do not allow vehicle parking on existing sidewalks.
- E. Provide and maintain access to fire hydrants and control valves free of obstructions.
- F. Remove mud from construction vehicle wheels before entering streets. Cleanup dirt, rocks, and debris left on street from construction vehicles.
- G. Use designated existing on-site roads for construction traffic.
- H. Maintenance:
 - 1. Maintain the traffic and parking areas in a sound condition free of excavated material, construction equipment, products, mud, snow, and ice.
 - 2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain the paving and drainage in original, or specified, condition.
 - 3. Plywood and other protections shall be provided when construction equipment is driven over concrete.
- I. Removal, Repair:
 - 1. Remove temporary materials and at Substantial Completion.
 - 2. Remove underground work and compacted materials to a depth of 2 feet; fill and grade the site as specified.
 - 3. Repair existing and permanent facilities damaged by use, to the original or specified condition.

1.13 INDEPENDENT FOOD VENDORS

- A. Independent or contracted food vendor trucks are prohibited on Rhode Island College's campus. Contractors are permitted to use college dining facilities (Donovan Dining, Café in Student Union, and The Galley Cafe in Building 3).

1.14 PROJECT IDENTIFICATION (IF REQUIRED)

- A. Project Identification Sign: One painted or printed sign, 32 sq ft area, bottom 6 feet above the ground.
 - 1. Contents:
 - a. Project title, and name of the User Agency as indicated on the Contract Documents.
 - b. Names and titles of the authorities.
 - c. Names and titles of the Design Agent and Consultants.

- d. Name of the Design Agent Contractor.
 2. Graphic Design, Colors, and Style of Lettering: 3 colors, as designated by the Design Agent during construction.
- B. Project Informational Signs:
1. Painted or printed informational signs of same colors and lettering as the Project Identification sign, or standard products; size lettering to provide legibility at 100-foot distance.
 2. Provide sign at each field office, storage shed, and directional signs to direct traffic into and within site. Relocate as the Work progress requires.
 3. No other signs are allowed without the User Agency's permission except those required by law.
- C. Design all signs and their structures to withstand a 60-miles/hr-wind velocity.
- D. Sign Painter or Printer: Experienced as a professional sign painter for a minimum of three years.
- E. Finishes, Painting or Printing: Adequate to withstand weathering, fading, and chipping for the duration of construction.
- F. Show content, layout, lettering, color, foundation, structure, sizes, and grades of members.
- G. Installation:
1. Install the project identification sign within 15 days after the date of receipt of the Purchase Order from State of Rhode Island Department of Administration, Division of Purchases.
 2. Erect at the designated location.
 3. Erect the supports and framing on a secure foundation, rigidly braced and framed to resist wind loadings.
 4. Install the sign surface plumb and level, with butt joints. Anchor securely.
 5. Paint exposed surfaces of the sign, supports, and framing.
- H. Maintenance: Maintain the signs and supports clean, repair deterioration and damage.
- I. Removal: Remove the signs, framing, supports, and foundations at the completion of the Project and restore the area.

1.15 TRAFFIC REGULATION

- A. Signs, Signals, And Devices:
- a. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As approved by local jurisdictions.
 - b. Traffic Cones and Drums, Flares and Lights: As approved by local jurisdictions.
 - c. Flag person Equipment: As required by local jurisdictions.
 - d. Police Details: Provide all police details as required by local jurisdictions, including payment directly to applicable jurisdiction.
 - e. On Campus Police Details: The User Agency shall provide and over costs for details provided by RIC Campus Police. If RIC is unable to provide, contractor shall provide flaggers and will be compensated for the flagger's hours.

- B. Flag Persons: Provide trained and equipped flag persons to regulate the traffic when construction operations or traffic encroach on the public traffic lanes.
- C. Flares and Lights: Use flares and lights during the hours of low visibility to delineate the traffic lanes and to guide traffic.
- D. Haul Routes:
 - 1. Consult with the authority having jurisdiction, establish the public thoroughfares to be used for haul routes and site access.
- E. Traffic Signs and Signals:
 - 1. At approaches to the site and on site, install at crossroads, detours, parking areas, and elsewhere as needed to direct the construction and affected public traffic.
 - 2. Install and operate automatic traffic control signals to direct and maintain the orderly flow of traffic in areas under the Contractor's control, and areas affected by the Contractor's operations.
 - 3. Relocate as the Work progresses, to maintain effective traffic control.
- F. Removal:
 - 1. Remove equipment and devices when no longer required.
 - 2. Repair damage caused by installation.
 - 3. Remove post settings to a depth of 2 feet.

1.16 BARRIERS

- A. Provide barriers to allow for the User Agency's use of the site and to protect existing facilities and adjacent properties from damage from the construction operations, or demolition.
- B. Provide barricades and covered walkways required by RIC for public rights-of-way, or for public access to the building.
- C. Provide protection for plants designated to remain. Replace damaged plants.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.17 ENCLOSURES AND FENCING

- A. Exterior: Contractor shall provide 6-ft. high commercial grade chain link fence that is properly secured and maintained around the building and/or site in order to protect the public and the work. Include in the Site Plan the location of the fence and pedestrian and vehicular gates for User Agency review. Access shall be available to all egress doors as designated by the User Agency. Provide visual screening on fence using fabric approved by the User Agency. Equip with vehicular and pedestrian gates with locks. Provide one set of keys to all gates and door locks to the User Agency.
- B. Perform adjustment to the proposed layout as may be directed by the User Agency.
- C. Contractor to provide overhead cover protection at all entrances and egresses from the building. Entrances and paths of egress must be clearly marked with signage with placement and language approved in advance by the User Agency.
- D. Staging of equipment, dumpsters and materials must be situated within the project fenced-in areas.
- E. Interior Enclosures:

1. Provide temporary partitions and ceilings as indicated to separate the work areas from User Agency-occupied areas, to prevent penetration of dust and moisture into User Agency-occupied areas, and to prevent damage to the existing materials and equipment.
2. Construction: Framing and reinforced polyethylene, plywood, or gypsum board sheet materials with closed joints and sealed edges at intersections with existing surfaces, as agreed with the User Agency: Maximum flame spread rating of 75 in accordance with ASTM E84.

1.18 SECURITY

A. Security Program:

1. Protect the Work, the existing premises, or the User Agency's operations from theft, vandalism, and unauthorized entry.
2. Initiate the program in coordination with the User Agency's existing security system at mobilization.
3. Maintain the program throughout the construction period until User Agency occupancy of each designated area.

B. Entry Control: Coordinate the access of the User Agency's personnel to the site in coordination with the User Agency's security forces. The Contractor is responsible for providing adequate locks for the site and furnish the requested quantities of keys to the User Agency.

1.19 FIRE DETECTION

- A. Before beginning any construction operation that can potentially trigger the existing fire alarm detection system, notify the User Agency through use of the form provided in Section 01 10 00.
- B. Failure to so notify the User Agency will subject the Contractor to a monetary fine for each occurrence, should the fire detection system be activated inadvertently by a construction activity.
- C. Comply with the User Agency's insurance underwriting standards and insurer recommendations for Hot Work, sprinkler impairment, and site maintenance.

1.20 WATER CONTROL

- A. Grade the site to drain. Maintain excavations free of water. Provide, operate, and maintain the pumping equipment.
- B. Protect the site from puddling or running water. Provide water barriers as required to protect the site from soil erosion.

1.21 DUST CONTROL

- A. Execute the Work by methods to minimize raising dust from construction operations.
- B. Provide positive means to prevent air-borne dust from dispersing into the atmosphere.

1.22 EROSION AND SEDIMENT CONTROL

- A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize the amount of bare soil exposed at one time.

- C. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
- D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
- E. Periodically inspect the earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.
- F. Follow Rhode Island DEM Soil Stabilization Requirements, including, but not limited to:
 - 1. Stabilizations of disturbed areas must, at a minimum, be initiated immediately whenever any clearing, grading, excavating or other earth disturbance activities have permanently ceased on any portion of the site, or temporarily ceased on any portion of the site and will not resume for a period exceeding fourteen (14) calendar days.
 - 2. Stabilization must be completed using vegetative stabilization measures or using alternative measures whenever vegetative measures are deemed impracticable or during periods of drought.
 - 3. All disturbed soils exposed prior to October 15th shall be seeded by that date.
 - 4. Any such areas which do not have adequate vegetative stabilization by November 15th must be stabilized through the use of non-vegetative erosion control measures.
 - 5. If work continues within any stabilized areas during the period from October 15th through April 15th, care must be taken to ensure that only the area required for that day's work is exposed, and all erodible soil must be stabilized within five (5) working days.

1.23 CLEANING

- A. Refer to Section 01 74 13 – Cleaning. Contractor to maintain a neat and orderly work site. Trash shall be cleaned from site and surrounding area on a daily basis.
- B. For projects within occupied buildings, contractor shall sweep and wet mop all floors on a daily basis for impacted spaces. Surfaces of desks, tables, etc. shall be covered during construction and cleaned of dust and debris.

1.24 NOISE CONTROL

- A. Provide methods, means, and facilities to minimize noise produced by the construction operations.

1.25 PEST AND RODENT CONTROL

- A. Provide methods, means, and facilities to prevent pests, insects and rodents from damaging the Work, or accessing or invading the facility.

1.26 POLLUTION CONTROL

- A. Provide methods, means, and facilities to prevent the contamination of soil, water, and the atmosphere from discharge of noxious, toxic substances, and pollutants produced by the construction operations.

1.27 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, and materials, prior to Substantial Completion.
- B. Remove the underground installations to a minimum depth of 2 feet. Grade the site as indicated.

- C. Clean and repair the damage caused by installation or use of temporary work.
- D. Restore the existing and new facilities used during construction to their original condition.
- E. Restore any temporary exterior laydown or storage areas to the original condition. After each use, regrade and reseed as required to meet this requirement.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 60 00 – PRODUCT REQUIREMENTS**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Products.
- B. Product delivery requirements.
- C. Product storage and handling requirements.
- D. Product options.
- E. Product substitution procedures.

1.2 PRODUCTS

- A. Products: Means new material, machinery, components, fixtures, or systems forming the Work; but does not include the machinery or equipment used for the preparation, fabrication, conveying, or erection of the Work. Products may include the existing materials or components required or specified for reuse.
- B. Furnish products of qualified manufacturers suitable for the intended use. Furnish products of each type by a single manufacturer unless specified otherwise.
- C. Do not use materials and equipment removed from the existing premises, except as specifically permitted by the Contract Documents.
- D. Furnish interchangeable components of the same manufacturer for the components being replaced.

1.3 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with the manufacturer's instructions.
- B. Promptly inspect shipments to ensure that the products comply with the requirements, the quantities are correct, and the products are undamaged.
- C. Provide equipment and personnel to handle the products by methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect the products in accordance with the manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to the product.
- D. For exterior storage of fabricated products, place on sloped supports above the ground.
- E. Provide bonded off-site storage and protection when the site does not permit on-site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent the condensation and degradation of products.

- G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store the products by methods to prevent soiling, disfigurement, or damage.
- I. Arrange storage of the products to permit access for inspection. Periodically inspect to verify that the products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any Product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of one of the manufacturers named and meeting the specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named in accordance with the following article.

1.6 PRODUCT SUBSTITUTION PROCEDURES

- A. Instructions to Bidders specify the time restrictions for submitting requests for Substitutions during the bidding period to requirements specified in this section.
- B. Substitutions may be considered after the bid only in the following circumstances:
 - 1. When a product becomes no longer in production following the date of receipt of the Purchase Order for this Contract. Submit certification both that specified product was carried in Bid, and is no longer obtainable. Provide cost change documentation.
 - 2. There is a significant cost savings offered to the User Agency. Provide price comparison of both bid and offered substitution products as well as all collateral costs of the change.
 - 3. Code changes or site conditions require a different item from that bid. Submit as for 2 above.
- C. Document each request with complete data substantiating the compliance of a proposed Substitution with the Contract Documents.
- D. A request constitutes a representation that the Bidder:
 - 1. Has investigated the proposed Product and determined that it meets or exceeds the quality level of the specified product.
 - 2. Will provide the same warranty for the Substitution as for the specified Product.
 - 3. Will coordinate the installation and make changes to other Work which may be required for the Work to be complete with no additional cost to the User Agency, including redesign.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 - 5. Will reimburse the User Agency and the Design Agent for review or redesign services, including those associated with re-approval by the authorities having jurisdiction.
- E. Substitutions will not be considered when they are indicated or implied on the Shop Drawing or Product Data submittals, without a separate written request, or when acceptance will require revision to the Contract Documents.

- F. Substitution Submittal Procedure, If Permitted Following Contract Award:
1. Submit three copies of a request for Substitution for consideration, no later than 20 working days following date of receipt of the Purchase Order for this Contract. Limit each request to one proposed Substitution. Identify product of fabrication or installation method to be replaced. Include Specification Section number and title and Drawing number and title.
 2. Submit the Shop Drawings, Product Data, and the certified test results attesting to the proposed product equivalence. The burden of proof is on the proposer.
 3. The Design Agent will notify the Contractor in writing of a decision to accept or reject the request. Costs for review time on unsuccessful requests will be included in the next change order.

PART 2 - PRODUCTS

- A. Insert any variations or "No variations in this section for this Project."

PART 3 - EXECUTION (NOT USED)**END OF SECTION**

01 71 00 – EXAMINATION, PREPARATION AND EXECUTION**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Examination & preparation.
- B. Field engineering.
- C. Protection of adjacent construction.
- D. Protecting installed construction.
- E. Materials used in cutting and patching.
- F. Preparation of cutting and patching.
- G. Special procedures.
- H. Selective demolition.
- I. Cutting and patching.

1.2 EXAMINATION & PREPARATION

- A. Acceptance of Conditions:
 - 1. Verify that existing applicable site conditions, substrates, or substrate surfaces are acceptable or meet specific requirements of individual specifications Sections, for subsequent Work to proceed.
 - 2. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.
 - 3. Examine and verify specific conditions described in individual specifications Sections.
 - 4. Verify that utility services are available, of correct characteristics, and in correct locations.
 - 5. Beginning of new Work, which relies upon the quality and proper execution of Work of a preceding trade, means acceptance of that preceding Work as appropriate for the proper execution of subsequent Work.
 - 6. Acceptance of preceding Work that can be shown later to have adversely affected proper performance of new Work may result in removal and repeat performance of all Work involved at no cost to the User Agency.
- B. Clean substrate surfaces prior to applying next material or substance.
- C. Seal cracks or openings of substrate prior to applying next material or substance.
- D. Apply substrate primer, sealer, or conditioner, required or recommended by manufacturer, prior to applying any new material or substance in contact or bond.
- E. Prior to the application, installation, or erection of any products and product components, perform any other preparatory operations, or surface or substrate modifications, as may be specified or directed by product manufacturers.

1.3 FIELD ENGINEERING

- A. Employ a Land Surveyor registered in the State of Rhode Island and acceptable to Design Agent and the User Agency.

- B. Locate and protect survey control and reference points. Promptly notify Design Agent of any discrepancies discovered.
- C. Control Datum for survey is to be agreed to with the Design Agent.
- D. Verify setbacks and easements, if any; confirm drawing dimensions and elevations.
- E. Provide field-engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.
- F. Submit a copy of site drawings and certificate signed by the Land Surveyor that the elevations and locations of the Work are in conformance with the Contract Documents.
- G. Maintain a complete and accurate log of control and survey work as it progresses.
- H. If required by the User Agency, on completion of foundation walls and major site improvements, prepare a certified survey illustrating dimensions, locations, angles, and elevations of construction and site work.
- I. Protect survey control points prior to starting site work; preserve permanent reference point during construction.
- J. Promptly report to Design Agent the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
- K. Replace dislocated survey control point based on original survey control. Make no changes without prior written notice to Design Agent.

1.4 PROTECTION OF ADJACENT CONSTRUCTION

- A. Protect existing adjacent properties and provide special protection where specified in individual Specification Sections.
- B. Provide protective coverings at wall, projections, jambs, sills, and soffits of existing openings.
- C. Protect existing finished floors, stairs, and other existing surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- D. Cover and protect furnishings, materials and equipment within the spaces receiving new work. Move items as necessary to install new work and return them to original locations at the close of construction in that area.
- E. Repair adjacent properties damaged by construction operations to original condition to the satisfaction of the User Agency.
- F. Prohibit unnecessary traffic from existing landscaped areas.

1.5 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections.
 - 1. IT wires shall not be painted. IT wires, faceplates, racks and other components shall be fully protected during painting activities. IT wires which have been painted or exposed to paint splatter shall be replaced and terminated at no cost to the User Agency upon request.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Repair or replace installed Work damaged by construction operations, as directed by the Design Agent.

PART 2 - PRODUCTS

2.1 MATERIALS USED IN CUTTING AND PATCHING

- A. Unless otherwise indicated, the Contractor shall provide materials for cutting and patching which will result in an equal-or-better product than the material being cut and patched, in terms of performance characteristics and including visual effects where applicable. The Contractor shall use material identical with the original materials where feasible.
- B. Match existing materials unless otherwise specified.
- C. Restore Work with new Products in accordance with requirements of Contract Documents.
- D. Materials shall comply with the requirements of the Technical Specifications found in individual Sections; match existing with new products, or salvaged products as appropriate, for patching and extending work.
- E. Provide submittals for approval to the Design Agent and User Agency.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor shall provide adequate temporary support for Work to be cut to prevent failure.
- B. The Contractor shall provide adequate protection of other Work during cutting and patching.
- C. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
- D. Identify any hazardous substance or conditions exposed during the Work to the User Agency and Design Agent for decision or remedy.
- E. By careful study of the Contract Documents, determine the location and extent of selective demolition and repairs to be performed.

3.2 SPECIAL PROCEDURES

- A. The Contractor shall use methods least likely to damage Work to be retained and Work adjoining. Provide proper surfaces to receive patching and finishing.
- B. Where physical cutting action is required, the Contractor shall cut Work with sawing and grinding tools, not with hammering and chopping tools. Openings through concrete Work shall be core-drilled or using a masonry saw.
- C. Remove ceiling tiles as necessary to access areas of work. Store and replace carefully to avoid damage. Replace all ceiling tiles damaged during the work with new tiles to match. Repair ACT grid damaged during the work in accordance with this section.
- D. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.
- E. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

- F. At penetration of fire rated partitions, ceiling, or floor construction, completely seal voids with fire rated or fire resistant material in accordance with Specifications, to full thickness of the penetrated element.
- G. All demolition work shall be carried on in such a manner that the existing building and site and their component parts will not be damaged. Any damage to the building shall be corrected by the Contractor, to the satisfaction of the User Agency and Architect, at no additional cost to the User Agency.
- H. Close openings in exterior surfaces to protect existing Work from weather and extremes of temperature and humidity.
- I. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.

3.3 SELECTIVE DEMOLITION

- A. Carefully demolish and remove from the building and site those items specified to be demolished and removed.
- B. Remove, cut, modify and patch as necessary to conduct Work in a manner to minimize damage and to provide means of restoring products and finishes to original or specified condition. Replace and restore at completion.
- C. Prepare and follow an organized plan for demolition and removal of items:
 - 1. Shut off, cap, and otherwise protect existing utility lines.
 - 2. Completely remove items scheduled to be so demolished and removed, leaving surfaces clean, solid, and ready to receive new materials specified elsewhere.
- D. Remove unsuitable material not marked for salvage, such as rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.
- E. Remove debris and abandoned items from area and from concealed spaces.
- F. The Contractor shall be responsible for the removal and disposal of all materials and equipment from the site and building during the project. Unless directed otherwise by the User Agency, all demolition materials to be removed from the site shall be disposed of in accordance with applicable laws and regulations. **User Agency shall have first right of refusal of any and all materials and equipment scheduled for removal.**
- G. In the event of demolition of items not so scheduled to be demolished, promptly replace such items to the approval of the Architect and at no additional cost to the User Agency.

3.4 CUTTING AND PATCHING

- A. Provide patching and repairs to all surfaces as indicated and as required for a complete and proper job, including all surfaces damaged as a result of the work of this Contract. Patch or replace portions of existing surfaces which are damaged, or shows imperfections not acceptable to the Design Agent or User Agency.
- B. Employ skilled and experienced installers to perform cutting and patching.
- C. Submit written request in advance of cutting or altering elements which affect:
 - 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.

5. Existing construction, or Work of separate contractor.
- 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 that will avoid damage to other Work, and provide proper surfaces to receive patching and finishing.
 - F. Cut masonry, concrete, and other rigid materials using masonry saw or core drill.
 - G. Remove ceiling tiles as necessary to access areas of work. Store and replace carefully to avoid damage. Replace all ceiling tiles damaged during the work with new tiles to match. Repair ACT grid damaged during the work in accordance with this section.
 - H. Restore Work with new Products in accordance with requirements of Contract Documents.
 - I. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.
 - J. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
 - K. At penetration of fire rated partitions, ceiling, or floor construction, completely seal voids with fire rated or fire resistant material in accordance with Specifications, to full thickness of the penetrated element.
 - L. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit. Ensure a neat transition to adjacent finishes
 - M. Identify any hazardous substance or conditions exposed during the Work to the Owner and Design Agent for decision or remedy.
 - N. Prepare surface and remove surface finishes to provide installation of new Work and finishes.
 - O. Trim existing doors as necessary to clear new floor finish. Refinish trim as required.
 - P. When completed, patches or repairs shall not be visible to the naked eye from a distance of 6 feet.
 - Q. Exterior Patching
 1. Any damage to buildings, roads, public roads, bituminous concrete areas, fences, lawn areas, trees, shrubbery, poles, underground utilities, etc. shall be made good by and at the Contractor's own expense, all to the satisfaction of the User Agency.
 2. The Contractor shall patch, repair and/or replace all adjacent materials and surfaces damaged after the installation of new work at no expense to the User Agency. All repair and replacement work shall match the existing in kind and appearance.
 3. Restore grassed landscaped areas damaged by construction operations to full healthy growth, by installing loam and sod to the requirements, and under the supervision of the user agency.
 - R. See General Conditions for additional requirements.

END OF SECTION

SECTION 01 73 00 - EXECUTION

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.

1.2 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Installation of the Work.
3. Cutting and patching.
4. Coordination of Owner-installed products.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.
8. Correction of the Work.

- B. Related Requirements:

1. Division 01 Section "Submittal Procedures" for submitting surveys.
2. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For land surveyor and/or professional engineer.
- B. Certificates: Submit certificate signed by land surveyor and/or professional engineer certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:

1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.
 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.
- D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- E. Certified Surveys: Submit two copies signed by land surveyor and/ or professional engineer.
- F. Final Property Survey: Submit two copies showing the Work performed and record survey data.

1.5 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-detection and -alarm systems.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
 - a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.

- c. Exterior curtain-wall construction.
 - d. Sprayed fire-resistive material.
 - e. Equipment supports.
 - f. Piping, ductwork, vessels, and equipment.
 - g. Noise- and vibration-control elements and systems.
4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.
- D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with requirements in Division 01 sustainable design requirements Section.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
- 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
- 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.

2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Division 01 Section "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

- B. General: Engage a professional engineer to lay out the Work using accepted surveying practices.
1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 2. Establish limits on use of Project site.
 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 4. Inform installers of lines and levels to which they must comply.
 5. Check the location, level and plumb, of every major element as the Work progresses.
 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

- E. Final Property Survey: Engage a land surveyor or professional engineer to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. 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.

- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.
- G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.

2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Division 01 Section "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.9 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Division 01 Section "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Division 01 Section "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

01 74 13 – CLEANING**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Cleaning requirements during construction operations.
- B. Final cleaning prior to turning the project over to the User Agency.
- C. Scope
- D. Related Documents
- E. Quality
- F. Contractor's Failure to Clean
- G. Cleaning Materials
- H. Construction in an Occupied Building
- I. Process Cleaning During Cleaning
- J. Final Cleaning

1.2 SCOPE

- A. This section specifies the requirements for maintaining a clean and orderly work site during and at the completion of the Work.
- B. Pay special attention to work areas that affect occupied spaces and public areas.

1.3 RELATED DOCUMENTS

- A. This section supplements Article 4.17 of the General Conditions.
- B. Consult the individual sections of the specifications for cleaning of Work installed under those sections.
- C. Cutting and Patching: Section 01 73 29.
- D. Pest Control: Comply with pest control requirements in Section 01 50 00.
- E. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 74 19.

1.4 QUALITY

- A. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
- B. Conduct all cleaning and disposal operations to comply with all federal, state, and local laws, regulations, codes, ordinances and by-laws.
 - 1. Do not burn or bury rubbish and waste materials on the site.
 - 2. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
 - 3. Do not dispose of wastes into streams or waterways.

- C. In cleaning items with manufacturer's finish or items previously finished by a Subcontractor, care shall be taken not to damage such manufacturer's or Subcontractor's finish. Any damage to finishes caused by cleaning operations shall be repaired at the Contractor's expense.

1.5 CONTRACTOR'S FAILURE TO CLEAN

- A. If the Contractor fails to maintain levels of cleanliness in work areas, satisfactory to the User Agency, then the User Agency shall have the right to cause such areas to be cleaned by others. The costs to the User Agency for such cleaning, plus 25% for administration, shall be the obligation of the Contractor and shall be deducted from any money due the Contractor hereunder.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned.
- B. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 - 1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 CONSTRUCTION IN AN OCCUPIED BUILDING

- A. Efforts must be taken to limit dust, noise and odors from escaping the work area. Proper separation and protection of interior spaces shall be established and maintained during the project, to the satisfaction of the User Agency. Contractor shall provide and maintain walk-off mats and plastic barriers at work site entries.
- B. Contractor shall provide appropriate masking of building supply air intakes to protect indoor air quality and limit transfer of odors. Contractor to provide air scrubbing and/or negative air machines to prevent odors from escaping the Project Site.
- C. Do not leave debris, tools or materials in occupied areas.
- D. Immediately following the completion of Work in an occupied area, Contractor shall pick up and stow all equipment and miscellaneous material leaving the site in a neat and safe condition.
 - 1. Occupied spaces must be returned to original conditions to the greatest extent possible by 8am weekdays. If it is not feasible to do as such, notify the User Agency immediately. With approval, the area shall be cordoned off with cones and caution tape and computer generated signage shall be posted to the satisfaction of the User Agency.
- E. Contractor shall ensure that horizontal and vertical surfaces in the occupied areas in the building impacted by construction activities are thoroughly vacuumed, wet mopped and cleaned to the satisfaction of the User Agency at the end of each shift, or upon request.

3.2 PROGRESS CLEANING DURING CONSTRUCTION

- A. Maintain areas under Contractor's control (including employee parking and Contractor's staging areas) free of waste materials, scraps, surplus material, debris and rubbish. Maintain site in a clean and orderly condition.
- B. Clean interior areas daily to provide suitable conditions for Work and to prevent fire or accidents. Sufficient time to clean up work zones shall be allocated at the end of the shift.
- C. All combustible waste materials shall be removed from buildings at the end of each working day.
- D. Wet down dry materials and rubbish to lay dust and prevent blowing dust.
- E. Vacuum clean interior building areas when ready to receive finish painting, and continue vacuum cleaning on an as-needed basis until Substantial Completion.
- F. Waste Management
 - 1. Collect and remove waste materials, debris, and rubbish from the site daily, as necessary to prevent an on-site accumulation of waste material, debris, and rubbish, and dispose off-site.
 - 2. Remove debris and rubbish from pipe chases, plenums attics, crawl spaces and other closed or remote spaces, prior to closing the space.
 - 3. Maintain the Site free from accumulations of waste, debris, and rubbish.
 - 4. Do not allow materials and rubbish to drop free or be thrown from upper floors, but remove by use of a material hoist or rubbish chutes.
 - 5. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.
 - 6. Provide on-site containers for collection of waste materials and rubbish.
- G. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.
- H. Broom clean interior areas prior to start of surface finishing and continue cleaning on a daily basis.
- I. Control cleaning operations so that dust and other particulates will not adhere to wet or newly-coated surfaces. Responsibility for construction cleaning shall not be delegated to subcontractors performing construction work under this Contract.
- J. Clean as required to ensure proper and lasting installation of equipment and finishes.

3.3 FINAL CLEANING

- A. Unless otherwise specified under other sections of the Specifications, the Contractor shall perform final cleaning operations as herein specified prior to final inspection.
- B. Cleaning shall include all surfaces, interior and exterior, which the Contractor has had access to, whether new or existing.
- C. Remove grease, mastic, adhesive, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior surfaces. This includes cleaning of the Work of all finishing trades where needed, whether or not cleaning by such trades is included in their respective specifications. Remove labels that are not permanent.
- D. Repair, patch, and touch up marred surfaces to the specified finish, to match adjacent surfaces.
- E. Polish glossy surfaces to a clear shine.

F. Site & Exteriors

1. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
3. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
4. Remove all cigarette buds and other litter.

G. Remove excess materials

1. Remove tools, construction equipment, machinery, and surplus material from Project site.
2. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
3. Remove all attic stock (extra materials) from the building and transmit per the User Agency's directive.

H. Interiors

1. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
2. Sweep concrete floors broom clean in unoccupied spaces.
3. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
4. Final Cleaning of resilient floors and wood floors shall be as specified under the respective sections of the Specifications.
5. Leave all architectural metals, hardware, and fixtures in undamaged, polished conditions.

I. Glass

1. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
2. Clean plastic glazing in accordance with the manufacturer's directions.
3. In cleaning glass and finish surfaces, care shall be taken not to use detergents or other cleaning agents which may stain adjoining finish surfaces.
4. All broken or defective glass caused by the Contractor's Work shall be replaced at the expense of the Contractor.

J. Cleaning of MEP Equipment

1. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
2. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
3. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

4. Clean ducts, blowers, and coils if units were operated during construction or that display contamination with particulate matter on inspection.
 5. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 6. Leave pipe and duct spaces, plenums, furred spaces and the like clean of debris and decaying materials.
- K. Prior to submitting a request to the Architect to certify Substantial Completion of the Work, the Contractor shall inspect all interior and exterior spaces and verify that all waste materials, rubbish, tools, equipment, machinery, and surplus materials have been removed, and that all sight-exposed surfaces are clean. Leave the Project clean and ready for occupancy.
- L. User Agency's responsibility for cleaning commences at occupancy, however Contractor shall provide satisfactory cleaning as requested or required as a result of Contractor activity in the project area or occupied spaces. .

END OF SECTION

SECTION 01 74 20 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and [construction waste.
- B. Related Requirements:
 - 1. Division 01 Section "Multiple Contract Summary" for coordination of responsibilities for waste management.
 - 2. Division 02 Section "Selective Structure Demolition" for disposition of waste resulting from demolition of site improvements.
 - 3. Division 04 Section "Unit Masonry" for disposal requirements for masonry waste.
 - 4. Division 31 Section "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of **75** percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:
1. Demolition Waste (which may include the following when within the project scope but not limited to):
 - a. Asphalt Shingles.
 - b. Built up Roof.
 - c. Soffits
 - d. Wood trim.
 - e. Metals.
 - f. Roofing.
 - g. Insulation.
 - h. Gypsum board.
 - i. Electrical conduit.
 - j. Ridge vents
 - k. Downspouts & Gutters
 2. Construction Waste (which may include the following when within the project scope):
 - a. Masonry and CMU.
 - b. Lumber.
 - c. Wood sheet materials.
 - d. Wood trim.
 - e. Metals.
 - f. Roofing.
 - g. Insulation.
 - h. Carpet and pad.
 - i. Gypsum board.
 - j. Piping.
 - k. Electrical conduit.
 - l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
 - 1) Paper.
 - 2) Cardboard.
 - 3) Boxes.
 - 4) Plastic sheet and film.
 - 5) Polystyrene packaging.
 - 6) Wood crates.
 - 7) Plastic pails.

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste and Form CWM-8 for demolition waste. Include the following information:
1. Material category.
 2. Generation point of waste.
 3. Total quantity of waste in tons).
 4. Quantity of waste salvaged, both estimated and actual in tons.
 5. Quantity of waste recycled, both estimated and actual in tons.
 6. Total quantity of waste recovered (salvaged plus recycled) in tons.
 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- 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. Qualification Data: For waste management coordinator and recovery technician.

1.7 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Waste Management Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." 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 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.

1.8 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and 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 and construction waste generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. 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 Form CWM-3 for construction waste and Form CWM-4 for demolition waste. 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.
 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. 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.
- D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use Form CWM-5 for construction waste and Form CWM-6 for demolition waste. Include the following:
 1. Total quantity of waste.
 2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
 3. Total cost of disposal (with no waste management).
 4. Revenue from salvaged materials.
 5. Revenue from recycled materials.
 6. Savings in hauling and tipping fees by donating materials.
 7. Savings in hauling and tipping fees that are avoided.
 8. Handling and transportation costs. Include cost of collection containers for each type of waste.
 9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

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 Division 01 Section "Temporary Facilities and Controls."
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.
- C. 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 three 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.
- D. 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, recycled, reused, donated, and sold.
 - 2. Comply with Division 01 Section "Temporary Facilities and Controls" 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 Receivers and Processors: Use only available recycling receivers and processors licensed to do business in the local area.
- C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Owner and Contractor.
- D. 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.
- E. 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.

3.3 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Grind asphalt to maximum 1-1/2-inch (38-mm) size.
 1. Crush asphaltic concrete paving and screen to comply with requirements in Division 31 Section "Earth Moving" for use as general fill.
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

3.4 RECYCLING CONSTRUCTION WASTE

- A. 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.
- B. 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.
 - a. Comply with requirements in Division 32 Section "Plants." for use of clean sawdust as organic mulch.
- C. 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 Division 32 Section "Plants." for use of clean ground gypsum board as inorganic soil amendment.

3.5 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, 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.
- C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

3.6 FORMS

- A. Form CWM-1 for construction waste identification.
- B. Form CWM-2 for demolition waste identification.
- C. Form CWM-3 for construction waste reduction work plan.
- D. Form CWM-4 for demolition waste reduction work plan.
- E. Form CWM-5 cost/revenue analysis of construction waste reduction work plan.
- F. Form CWM-6 cost/revenue analysis of demolition waste reduction work plan.
- G. Form CWM-7 for construction waste
- H. Form CWM-8 for demolition waste.

END OF SECTION 01 74 20

01 78 00 – CLOSEOUT PROCEDURES AND SUBMITTALS**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Related Requirements
- B. Definitions
- C. Quality Assurance
- D. Starting And Adjusting of Systems
- E. Demonstration and Instructions
- F. Substantial Completion
- G. Spare Parts and Maintenance Products
- H. Product Warranties and Product Bonds
- I. Emergency Contacts List
- J. Final Completion
- K. Project Turnover
- L. Mark-up Set of Construction Documents
- M. Administrative Closeout
- N. Owner's Manual
- O. Project Record Documents
- P. Final Application for Payment.

1.2 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Individual Product Sections: Specific requirements for operation and maintenance data.
- C. Individual Product Sections: Warranties required for specific products or Work.

1.3 DEFINITIONS

- A. Substantial Completion: refer to General Conditions A201 §9.8.1.
- B. Project Closeout is the period of time after the Substantial Completion date until the Contractor, Design Agent and User Agency have completed all contract items, closeout obligations, and processed final payment. This time period may overlap a portion of the warranty period.
- C. Warranty period is one year from the Substantial Completion date, unless specified otherwise. Individual products and work performed may have longer specific warranty periods as outlined in the Certificate of Substantial Completion. The warranty period may also be referred to as "Post Construction Phase".

1.4 QUALITY ASSURANCE

CLOSEOUT PROCEDURES AND SUBMITTALS

- A. Employ personnel assembling submittals experienced in the maintenance and the operation of the described products and systems.

1.5 STARTING AND ADJUSTING OF SYSTEMS

- A. Coordinate schedule for starting and adjusting of various equipment and systems.
- B. Notify Design Agent and User Agency seven days prior to starting and adjusting of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
- D. Verify that tests, meter readings and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute starting and adjusting under supervision of responsible Contractor's personnel or manufacturer's representative, in accordance with manufacturer's instructions.
- G. Adjust operating Products and equipment to ensure smooth and unhindered operation.
- H. When specified in individual specifications Section, require manufacturer to provide authorized representative to be present at the site to inspect, check, and approve equipment or system installation prior to starting, and to supervise placing of equipment or system in operation.
- I. Submit a written report in accordance with Section 01 40 00 that equipment or system has been properly installed and is functioning correctly.

1.6 DEMONSTRATION AND INSTRUCTIONS

- A. Provide training and demonstrations of the equipment and sequences of systems operation to User Agency's personnel two weeks prior to date of Substantial Completion.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- C. Training and demonstrations to include the following in conjunction with designated Operations personnel:
 - 1. Operate the equipment and systems for a minimum of two hours or five repetitions, or as otherwise required. If problems occur, correct them and repeat the full demonstration.
 - 2. Demonstrate proper equipment and systems operation, as well as procedures for cleaning, lubrication, maintenance, replacement of routine expendable parts and all other actions required for normal operations and maintenance.
 - 3. Demonstrate and review both normal and failure modes of system controls operation where they are designed as such.
 - 4. Review O&M manuals
 - 5. Place systems into full operation
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manuals with User Agency's personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled or agreed upon times, at equipment or system location.

- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. For each training session, Contractor shall provide written verification of training including, date, time, name of trainer, systems demonstrated, and agenda. Contractor shall prepare and submit a sign in sheet with name, email, title, phone number and signature of all attendees. This shall be turned over as part of the closeout package.

1.7 SUBSTANTIAL COMPLETION

- A. Refer to General Conditions §9.8 Substantial Completion for more information.
- B. The User Agency will occupy all portions of the building after Substantial Completion as specified in Section 01 10 00.
- C. Per RI General Laws § 37-12-10.1, Contractor shall notify User Agency and Design Agent that work is considered substantially complete utilizing the format indicated in the statute. A walk-through inspection for determining the date of Substantial Completion will be scheduled. Prior to the request, the following items shall be completed:
 - 1. All security, network and telecommunications and door access shall be complete.
 - 2. Complete startup and testing of mechanical, electrical and plumbing systems.
 - 3. Completion of Demonstration and Instructions
 - 4. Contractor shall prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete. The Design Agent shall review and perform an inspection
 - 5. Testing and balance reports are available.
 - 6. Request and complete commissioning and inspection.
 - 7. Deliver tools, spare parts, extra materials, and similar items to location designated by User Agency, per requirements, below.
 - 8. Make final changeover of permanent locks and deliver keys and keying schedule to User Agency. Advise User Agency's personnel of changeover in security provisions.
 - 9. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 10. Submit changeover information related to heat and other utilities, and User Agency's occupancy, use, operation, and maintenance.
 - 11. Complete final cleaning requirements, including touchup painting.
 - 12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
 - 13. Obtain and submit releases permitting User Agency unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar re-leases.
- D. Following demonstration of compliance with the items above, and as stipulated in RI General Laws § 37-12-10.1, Design Agent shall prepare a Certificate of Substantial Completion. At such time, Contract may submit an Application for Payment releasing held retainage.

1.8 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Furnish spare parts, maintenance, and extra products (attic stock) in the quantities specified in the individual specification Sections.
- B. Deliver to the Project site and place in a location as directed by the User Agency; obtain a receipt prior to final payment.
- C. See Owner's Manual, below, on submission of documentation.

1.9 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Warranty period shall commence at date of substantial completion.
- B. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with User Agency's permission, leave date of beginning of time of warranty until the Date of Substantial completion is determined.
- C. Retain warranties and bonds until time specified for submittal.
- D. Execute and assemble the transferable warranty documents and bonds from the subcontractors, suppliers, and manufacturers.
- E. Verify that the documents are in the proper form, contain full information, and are notarized.
- F. Include in the Operations and Maintenance Manuals within the appropriate material specification section, indexed separately on Table of Contents.
- G. Closeout Submittals Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with User Agency's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.
- H. See §3.3 Owner's Manual, below, on submission of documentation. At Final Completion of all work as certified by the College and Architect/Engineer, the Contractor shall deliver a Letter of Warranty to the College. This Warranty certifies that the Contractor shall promptly replace or repair any defects in equipment, materials or workmanship that becomes apparent within one (1) year from the date of Final Completion, or the College's acceptance of the Project, whichever is later.
- I. The Warranty shall include repairs and corrections to pipe covering, paint, woodwork, or any other material and equipment caused to be imperfect due to defective workmanship or materials. All direct and consequential repairs shall be entirely at the expense of the Contractor.
- J. Additional manufacturers' extended warranties for major equipment shall be supplementary to this guarantee.

1.10 EMERGENCY CONTACT LIST:

- A. Construction Contacts:
 - 1. During the course of construction, the Contractor shall supply a telephone number that the College may call on a twenty-four (24) hour/day basis for emergency repairs or service made necessary because of Contract work in progress.

2. Coordinate with the Project Manager to complete and file form with Facilities Service Response Center.
- B. Warranty Period Contacts:
1. Provide a telephone number that the College may call on a twenty-four (24) hour/day basis to receive immediate repairs and service, during the Warranty period. If the College is unable to contact the Contractor to obtain service, the College shall arrange for service from another service provider or College employees and shall charge the expenses to the Contractor.

1.11 FINAL COMPLETION

- A. Refer to General Conditions Article 9.10 Substantial Completion for more information.
- B. In order for Final Payment to be accepted, the following must be complete:
1. Resolution of all outstanding punch list items
 2. Final inspection of the project by the User Agency, Design Agent and Contractor
 3. Final inspections and certifications from authorities having jurisdiction.
 4. Acceptance of all Closeout Documentation (See Part 3 – Execution for Details).
 - a. Administrative Closeout
 - b. Owner's Manual
 - c. Project Record Documents
 - d. Final Application for Payment
- C. See Owner's Manual, below, on submission of documentation.

1.12 PROJECT TURNOVER:

- A. Sign off of the punch list is required for approval of the final Application for Payment.
- B. At the time of Substantial Completion, the Contractor shall coordinate with the College's Project Manager to schedule a project turnover meeting. This meeting shall include the College's Project Manager, Contractor, Sub-Contractors, Architect/Engineers (if applicable) and the College's Operations & Engineering representatives.
- C. Commissioning Review: The project Commissioning Agent's final report detailing their findings, recommendations, and summary of any open issues shall be made available and reviewed in the course of the Project Turnover Meeting(s).

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MARK-UP SET OF CONTRACT DOCUMENTS

- A. During construction, Contractor shall maintain one set of contract documents at the site, dedicated for use as a Mark-Up Set of Contract Documents. The Mark-Up Set is separate from documents used for construction and shall include:
1. Drawings and Specifications, including any bid addenda
 2. Specifications.

CLOSEOUT PROCEDURES AND SUBMITTALS

3. RFIs, ASIs and Sketches
 4. Change Orders and other modifications to the Contract.
 5. Reviewed Shop Drawings, Product Data, and Samples.
 6. Manufacturer's instructions for assembly and installation.
- B. Contractor shall record actual revisions of the Work for all trades, marking up plans and specifications as construction progresses and maintain continuously during the project.
- C. The plans shall be marked to show deviations in actual construction from the contract drawings. Deviations shall be shown in the same general detail utilized in the contract drawings. The drawings shall show the following information, but not be limited to:
1. Locations and descriptions of any utilities constructed or located within the construction limits. Provide survey point numbers on the plans for reference.
 2. Locations and dimensions of changes within the facility. Floor plan/layout changes should also include revised room numbers, as physically tagged in the field.
 3. Changes in grade, alignment, location, elevations, details, and dimensions of all work including facilities, structures, roads and utilities.
 4. Incorporate approved sketch (SK) drawings.
 5. Where the contract drawings show options, show only the option used in construction.
- D. Record information concurrent with the construction progress, not less than weekly.
- E. Failure to maintain accurate as-built mark-ups will constitute sufficient justification for withholding payments to the Contractor.
- F. Maintain the Mark-Up Set (site "red-lines") so that it may be available for review by the Architect, College, and the College's representatives.
- G. The corrections on the Mark-Up set shall be incorporated into original contract plan CAD files for final delivery to the College as part of Project Record Documents, below. All plans shall be included in the set.

3.2 ADMINISTRATIVE CLOSEOUT

- A. Prepare and submit electronically and one (1) hard copy the following documentation to the User Agency. Each of the sections of Administrative Closeout shall be individual .pdf files emailed to the User Agency's Representative, copied to the Design Agent. All submissions shall be accompanied by a Transmittal Form indicating the date of the transmission and items included in the package.
1. Certification of Work: Submit a written certification that the Contract Documents have been reviewed, the Work has been inspected, and that the Work is complete in accordance with the Contract Documents and is ready for the User Agency's review.
 2. Asbestos Abatement Compliance: Provide submittals to Design Agent that are required by governing or other authorities, including abatement documentation, including but not limited to waste manifests, air clearance testing reports and other documentation correctly prepared as proscribed in the abatement plan. Failure to include correctly prepared abatement documentation will delay issuing of final payment.
 3. AIA Document G706 - Contractor's Affidavit of Payment of Debts and Claims
 4. AIA Document G706A - Contractor's Affidavit of Release of Liens
 5. AIA Document G707 - Consent of Surety to Final payment

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3.3 OWNER'S MANUAL

A. Content of Owner's Manual:

1. Title Page
2. Table of Contents
3. Project Overview
4. Project Team Contact List
5. Summary Equipment List
6. Operations and Maintenance Documentation, Organized by Specification Section
7. Materials and Finishes Schedule
8. Roofing and Building Envelope
9. Spare Parts and Maintenance Products Turnover Documentation

B. Preparation of Owner's Manual: Project Overview.

1. Provide Summary of the scope of work of the project.
2. Schedule summary including start date, completion date, and start and end date of the project Guarantee.

C. Preparation of Owner's Manual: Project Team Contact List

1. Directory, listing the names, addresses, and telephone numbers of the Design Agent, its Consultants, Contractor, Subcontractors, and major equipment suppliers.
2. Specifically list out Emergency contact list with contact names and twenty-four (24) hours contact information for use during the guarantee/maintenance period.

D. Preparation of Owner's Manual: Summary Equipment List

1. The Contractor shall compile a Summary Equipment List for all new equipment provided under the project. For renovation projects, include a separate spreadsheet for all equipment removed under the project
2. Contractor shall utilize the Owner's Standard Building Equipment Data Sheet template, providing information including but not limited to: make, model name, model number, serial number, location and area served. Include the name of subcontractors and suppliers, including local source of supplies and replacement parts. Ensure that all subcontractors, suppliers and replacement part providers are included in the Project Team Contact List.
3. Summary Equipment List shall be provided in both .pdf and editable Microsoft Excel.

E. Preparation of Owner's Manual: The Operations and Maintenance Documentation. Contractor shall assemble a complete set of Operations and Maintenance (O&M) manuals indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. The Operations and Maintenance Documentation shall be organized by specification section and divided by each product or system. Provide the following information as applicable, separated with subdivides within each :

1. Product cover page: System Name; Brand; Warranty Summary & Contact; Specification section; Description of purpose and area served; Names, addresses, and telephone numbers of the Subcontractors and suppliers.
2. Significant design criteria.

3. Each Item of Equipment and Each System: Include a description of the unit or system, size capacity, pressure drops, horsepower and the component parts. Identify the function, normal operating characteristics, and limiting conditions. As applicable, include performance curves, with priming data and tests, and complete nomenclature and model number of replaceable parts.
4. Final approved shop drawings, submittal and cut sheet data detailing equipment performance data and features. For shop drawings: Provide with reinforced punched binder tab. Bind in with the text; fold the larger drawings to the size of the text pages.
5. For each component, include the original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
6. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.
7. Routine and Preventative Maintenance Requirements: Include the manufacturer's printed operation and maintenance instructions. Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions. Include a servicing and lubricating schedule, and a list of lubricants required. Include a list of the original manufacturer's spare parts, Predicted life of parts subject to wear current prices, and recommended quantities to be maintained in storage.
8. Maintenance instructions for [special] finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
9. Originals of product warranties and bonds.
10. Other information as specified in the individual product specification Sections.
11. Building Products, Applied Materials, and Finishes: Include product data, with the catalog number, size, composition, and the color and texture designations. Include information for re-ordering custom manufactured products.
12. Instruction for Care and Maintenance: include manufacturer's instructions for cleaning agents and methods, precautions against detrimental agents and methods, and a recommended schedule for cleaning and maintenance.
13. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.
14. Charts of valve tag numbers, with the location and function of each valve.
15. Equipment performance field test results, including HVAC system Test and Balancing (TAB) Report, motor alignment tests, etc.
16. Electrical short circuit studies, circuit protective device coordination studies and arc flash studies
17. Electrical panelboard and switchboard schedules
18. As installed schedules for lighting fixtures, lamps, and ballasts
19. Other data as required under pertinent sections of specifications
20. Provide and install framed charts in appropriate building MEP rooms for One Line diagrams, process flow diagrams and valve charts.
21. Software: Provide copies of system software and device configuration files for all electronic systems installed under the project. Files to be provided on formatted CD, mass

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storage device or other acceptable media. Include applicable software documentation and User Manuals. Systems requiring software backup include but are not limited to:

- a. Building Automation Systems (BAS)
- b. Fire Alarm Systems and Smoke Control Systems
- c. Elevator Controls
- d. Lighting Controls

22. Door Access Control Systems

23. Additional information required for Electrical, Controls and HVAC Sections:

- a. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
- b. Include sequence of operation by the controls manufacturer.
- c. Include color-coded wiring diagrams and process flow diagrams as installed for applicable systems: One Line and Process Flow diagrams (11x17) for applicable systems: Mechanical (heating, cooling, piping, process water and specialty systems), HVAC (Air handlers, ductwork, piping), Plumbing, Electrical (normal, standby power systems and specialty systems), Fire Alarm and Security and Telecom
- d. Include control diagrams by the controls manufacturer as installed.
- e. Include the Contractor's coordination drawings, with color-coded piping diagrams as installed.
- f. Include charts of valve tag numbers, with the location and function of each valve, keyed to the flow and control diagrams.
- g. Include test and balancing reports as specified in Section 01 40 00.
- h. Boiler and elevator and other applicable certificates and operating permits/licenses, DEM permits including generator permits
- i. Test and inspection documentation including fire pump test data, asbestos abatement plans and manifests.

F. Materials and Finishes Schedule shall be submitted in conjunction with O&M manual general requirements. Materials and Finishes manual is for architectural products, applied materials and finishes.

1. Final As-Built surfaces finish schedule, keyed to reduced size floor plans.
2. Additional Requirements: As specified in the individual product specification Sections.

G. Spare Parts and Maintenance Products Turnover Documentation: provide signed transmittals indicating materials delivered, date, location, name, title and signature of person who received the items.

H. Formatting

1. Submit the Owner's Manual bound in 8-1/2 x 11 inch text pages, in minimum 2 inch size three D side ring commercial quality binders with durable cleanable plastic covers. Pages shall be duplex printed.
2. Prepare binder covers with the typed title of the manual, title of the project, and the subject matter of binder. Label each spine with the following: Building, project or facility name, project number, submission date.
3. Internally subdivide the binder contents with typed permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated

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plastic tabs. Tabs shall match the headings provided in 3.3.A, Content of Owner's Manual, above.

4. The Electronic format shall be organized by Construction Specification Institute (CSI) divisions and include all materials/equipment/systems installed in the building. There shall be one pdf file created for each CSI division.
 5. Electronic .pdf shall be "OCR" keyword searchable, bookmarked by section. File and folder names shall be as mutually agreed.
- I. Draft Submission
1. Submit electronically a preliminary draft of the Owner's Manual thirty (30) calendar days prior to the contractual Substantial Completion date. The Design Agent and its consultants will review drafts and return electronically with comments. Contractor shall make revisions as noted.
 2. A resubmitted draft shall be provided electronically and as one (1) hard copy at contractual Final Completion. This copy will be reviewed and returned after final inspection, with the Design Agent's comments. Revise the content of the document sets as required prior to final submission.
- J. Final Submission: Submit three (3) sets of revised final volumes plus electronic copy in final format within ten (10) days after receipt of final comments.

3.4 PROJECT RECORD DOCUMENTS

- A. Project Record Documents shall comprise of the following:
1. As-Built Drawings.
 2. Record Specifications.
 3. Record Contract.
- B. Preparation of As-Built Drawings
1. At the end of construction, the Design Agent will provide to the Contractor a complete set of CAD file(s) with all the plan adjustments (bid addenda, bulletins and sketches produced by the Design Agent) fully incorporated into the base CAD file(s). This shall happen within 14 days of Substantial Completion.
 2. The Contractor shall retain Competent Drafting Personnel and will coordinate the process to take all field changes/adjustments by all Subcontractors. The Competent Drafting Personnel shall transfer this information and the Mark-Up Set accurately to the CAD file(s). All hand-drawn SK's that are not included in the Design Team's electronic update must be added to the CAD file(s) by the Contractor.
 3. The Contractor shall also include any electronic "MEP coordination drawings" produced by the construction team in the final electronic As-Builts. The coordination drawings shall not replace any of the original contract drawings, and they shall be fully labeled both to demonstrate the area of the building shown and to identify all elements shown on the plan. If abbreviations are used, a key must be included on these plans.
 4. Include site surveys and As Built. Measured horizontal and vertical locations of the underground utilities and appurtenances, referenced to permanent surface improvements. Include the locations and description of any existing utility lines and other existing installations of any kind or description encountered during construction. Note all changes in size, material, location, and elevation of all new or abandoned underground utility lines and pertinent work, including site grading. Document topography and drainage changes. Show the location of all valves, manholes, etc. and include dimensions to permanent fea-

CLOSEOUT PROCEDURES AND SUBMITTALS

- tures such as building corners. Note direction of each new valve opening. Show clearances between new utilities and existing crossed lines. Locate all bends, thrust blocks, and other restraints.
5. The placement, size, and type of any fire extinguishers.
 6. Measured locations of internal utilities and appurtenances concealed in the construction.
 7. Details not on the original Contract drawings, including field changes of dimension and detail.
 8. The Contractor will ensure that all notes and schedules included in the design drawings are updated to accurately reflect actual installed conditions.
 9. The As-Built Drawings shall include a cover page and content index.
 10. As-built Drawings shall be labeled so that the following information is legible when rolled as well as on a cover page: Building, project or facility name, Design Agent's project number, and submission date.
- C. Preparation of Record Specifications: Include cover page, title page, table of contents and tabulated and divided by Specification Section. Prepare in binders and electronically as per 3.4.E, Format, below. For each Specification, prepare a summary and provide documentation as follows. Each page shall include the Specification Section Number and Title.
1. Part 1 – General: Statement of compliance with General subsection or description of any deviations
 2. Part 2 – Products: For each installed item covered in the Specification Section, provide a copy of the Product Cover Page (from the Owner's Manual).
 3. Part 3 – Execution: Statement of compliance with Execution subsection or description of any deviations. Include any ASI or RFI responses in support of actual installation.
- D. Preparation of Record Contract: Include cover page, title page, table of contents and tabulated and divided. This list is not all inclusive; final list shall be agreed upon with Design Agent and User Agency, based on review of the draft.
1. State Purchase Order
 2. Bid Form
 3. Executed AIA A101 as amended by the state and A201 as amended by the state
 4. State Change Orders, including Purchase Order, AIA Cover Sheet and Backup. Provide a tab for each Change Order.
 5. Correspondence and Project Meeting Minutes.
 6. Copies of Contractor's project warranty letter, Subcontractor warranty letters and special guarantees and warranties such as roofing, waterproofing, windows and doors as applicable.
 7. Project Documents and Certificates (trade permits and 128 Forms, Final Certificate of Occupancy, etc.).
 8. Certificate of Substantial Completion
 9. Original and Updated Project Schedules
 10. Project Progress Photographs
 11. Additional Associated Materials. Each shall be considered a separate section, identified in the table of contents and divided as such. Example items include but not limited to:

- a. National Grid Rebate Applications.
 - b. If the project required geotechnical, archeological, or other miscellaneous studies or other reports, these shall also be submitted as Record Documents.
- E. Project Record Documents Format: Printed
1. As Built Drawings shall be organized into 3 sets, stapled with edge binding. The title block, visible when drawings are rolled, shall state the building name, title of the project, substantial completion date, Design Agent and Contractor.
 2. Record Specifications and Record Contract Documents shall be printed duplex on 8-1/2 x 11 inch text pages, in minimum 2 inch size three D side ring commercial quality binders with durable cleanable plastic covers.
 3. Prepare binder covers and spline labels with the printed title of "Project Record Documents", building name, title of the project, substantial completion date, Design Agent and Contractor, and the subject matter of binder.
 4. Provide cover pages and internally subdivide the binder contents with permanent page dividers, based on the following sections, as applicable.
- F. Project Record Documents Format: Electronic
1. All .pdf shall include bookmarks for Sections and be "OCR" keyword searchable.
 2. Folder structures and file names shall be as agreed.
- G. Project Record Document Draft
1. Contractor shall prepare an electronic draft of the project record documents for review by the Design Agent and the User Agency fifteen (15) days prior to final inspection, or within twenty-one (21) days of receipt of updated electronic files from the Design Team, whichever comes first.
 2. Ensure the entries are complete and accurate, enabling future reference by the User Agency.
 3. All Design Agent and User Agency comments/mark-ups on the draft package shall be returned to the Contractor within twenty-one (21) calendar days. The Contractor shall make corrections as noted and resubmit within twenty-one (21) calendar days.
- H. Final Submission
1. Within fifteen (15) calendar days of receiving final approval of the corrected drafts, the Contractor shall submit three (3) printed, bound copies and one (1) electronic copy of all documents.

3.5 FINAL APPLICATION FOR PAYMENT

- A. Refer to AIA A101-2017 as amended by the state §5.2. Following the requirements of Section 01 20 00, submit the final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due to the Design Agent.
- B. Design Agent shall work with the User Agency to determine that all requirements have been fulfilled, and if so, issue a final Certificate for Payment.

END OF SECTION

SECTION 01 78 30 - PROJECT RECORD DOCUMENTS

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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Division 01 Section "Execution" for final property survey.
 - 2. Division 01 Section "Closeout Procedures" for general closeout procedures.
 - 3. Divisions 02 through 10 Sections for specific requirements for project record documents of the Work in those Sections.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints.
 - 2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints and one set(s) of prints.
 - 2) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report weekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 2. Format: Annotated PDF electronic file.
 3. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 4. Refer instances of uncertainty to Architect for resolution.
 5. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Division 01 Section "Submittal Procedures" for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
 2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- D. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as annotated PDF electronic file.

1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean,

dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 01 78 30

SECTION 02 41 20 - SELECTIVE STRUCTURE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of existing elevator system.
3. Demolition and removal of selected site elements.
4. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Division 01 Section "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Division 01 Section "Historic Treatment Procedures" for historic removal and dismantling.
3. Division 01 Section "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
4. Division 01 Section "Execution" for cutting and patching procedures.
5. Division 31 Section "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner and/or ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

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

- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's and other tenants' on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
- E. Pre-demolition Photographs or Video: Submit before 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.
- G. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.
- B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
- C. Rhode Island Department of Labor and Training, Division of Occupational Safety-Elevator Unit form for NOTICE OF DECOMMISSION.

1.8 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner 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. Hazardous materials will be removed by Owner before start of the Work.
 - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Hazardous Materials: Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
 - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
 - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
 - 3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- F. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.
- G. Storage or sale of removed items or materials on-site is not permitted.

- H. 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.

1.10 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. 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.
- E. Perform and/or 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 selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

2. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- F. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs, preconstruction videotapes and/or templates as indicated. If not indicated, provide preconstruction photographs for record.
1. Comply with requirements specified in Division 01 Section "Photographic Documentation."
 2. 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.
 3. 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.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
1. Comply with requirements for existing services/systems interruptions specified in Division 01 Section "Summary."
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
1. **Owner or Building manager** will arrange to shut off indicated services/systems when requested by Contractor.
 2. Arrange to shut off indicated utilities with utility companies.
 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
- C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective 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 Division 01 Section "Temporary Facilities and Controls."
- B. 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 Division 01 Section "Temporary Facilities and Controls."
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.

3.4 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 Division 01 Section "Construction Waste Management and Disposal" when provided.
- B. Work in Historic Areas: Selective demolition may be performed only in areas of the Project that are not designated as historic. In historic spaces, areas, and rooms or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling" as specified in Division 01 Section "Historic Treatment Procedures."
- C. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area as indicated on Drawings.
 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. 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.

3.5 SELECTIVE 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 (19 mm) 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. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw; and then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

- E. 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.
- F. 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. See Division 07 Section for new roofing requirements.
 - 1. Remove existing roof membrane, flashings, copings, and roof accessories.
 - 2. Remove existing roofing system down to substrate.
- G. Existing Elevator: Remove existing elevator system in location identified in contract documents. Coordinate removal with requirements of RI Elevator inspector, RIDLT (Rhode Island Department of Labor and Training), and OTIS elevator decommissioning requirements. Existing elevator hoist way to remain-in-place. Provide barricades, and signage at each landing indicating elevator is "Out of Service". Disconnect electrical power to all areas of lift machinery as appropriate. Lock-out and tag at source of supplies when no longer needed. Provide completed Notice of Decommission.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 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. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials and dispose of at designated spoil areas on Owner's property.
- D. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

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

END OF SECTION 02 41 20

SECTION 03 30 00 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for drainage fill under slabs-on-grade.
 - 2. Division 2 Section "Cement Concrete Pavement" for concrete pavement and walks.
 - 3. Division 3 Section "Concrete Toppings" for metallic and nonmetallic concrete floor toppings.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and silica fume.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mix water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- D. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
- E. Welding Certificates: Copies of certificates for welding procedures and personnel.
- F. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.
- C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
 - 1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
- D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- F. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code-- Reinforcing Steel."
- G. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
 - 1. ACI 301, "Specification for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."
 - 1. Before submitting design mixes, review concrete mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixes.
 - c. Concrete subcontractor.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
 - 1. Avoid damaging coatings on steel reinforcement.
 - 2. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1, or better.

- b. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.
 - c. Structural 1, B-B, or better, mill oiled and edge sealed.
 - d. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.
 - B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
 - C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
 - D. Form Ties:
 - 1. Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 2. Furnish units that will leave no corrodible metal closer than 1-1/2" inch to the plane of the exposed concrete surface.
- 2.2 STEEL REINFORCEMENT
- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
 - B. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, and as follows:
 - 1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60, deformed.
 - C. Plain-Steel Wire: ASTM A 82, as drawn.
- 2.3 REINFORCEMENT ACCESSORIES
- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
 - B. Joint Dowel Bars: Stainless Steel Bars. Cut bars true to length with ends square and free of burrs.
- 2.4 CONCRETE MATERIALS
- A. Portland Cement for foundation walls and footings: ASTM C 150, Type I.
 - 1. Fly Ash: ASTM C 618, Class F.
 - B. Portland Cement for slabs on grade: ASTM C 150, Type II or V.
 - 1. Fly Ash: ASTM C 618, Class F.
 - C. Blended Hydraulic Cement: ASTM C 595M, Type I (PM), pozzolan-modified portland cement.
 - D. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:
 - 1. Class: Severe weathering region, but not less than 3S.
 - 2. Nominal Maximum Aggregate Size: 3/4 inch.
 - E. Water: Potable and complying with ASTM C 94.
- 2.5 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- G. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Catexol 1000CL; Axim Concrete Technologies.
 - b. MCI 2000 or MCI 2005; Cortec Corporation.
 - c. DCI or DCI-S; W. R. Grace & Co., Construction Products Div.
 - d. Rheocrete 222+; Master Builders, Inc.
 - e. FerroGard-901; Sika Corporation.
- H. FIBER REINFORCEMENT
 - I. Synthetic Fiber: Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches lo

2.6 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Profile: As indicated.
- B. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Profile: As indicated.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Rubber Waterstops:
 - a. Greenstreak.
 - b. Progress Unlimited Inc.
 - c. Westec Barrier Technologies; Div. of Western Textile Products, Inc.
 - 2. PVC Waterstops:
 - a. Greenstreak.
 - b. Meadows: W. R. Meadows, Inc.
 - c. Vinylex Corporation.
- D. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophylic material for adhesive bonding to concrete.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Volclay Waterstop-RX; Colloid Environmental Technologies Co.

- b. Hydrotite; Greenstreak.
- c. Mirastop; Mirafi Moisture Protection, Div. of Royal Ten Cate (USA), Inc.

2.7 VAPOR RETARDERS

- A. Vapor Retarder: ASTM E 1745, Class B, five-ply, nylon- or polyester-cord-reinforced, high-density polyethylene sheet; 15 mils thick.
 - 1. Available Product: Subject to compliance with requirements, a product that may be incorporated into the Work includes, but is not limited to, "Griffolyn T-85" by Reef Industries Inc.
- B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; meeting deleterious substance limits of ASTM C 33 for fine aggregates.

2.8 FLOOR AND SLAB TREATMENTS

- A. Penetrating Liquid Floor Treatment: Chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

2.9 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.10 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
 - 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
 - 2. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Reglets: Fabricate reglets of not less than 0.0217-inch- thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- E. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.11 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
 - 1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 3000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.48
 - 3. Maximum Slump: 4 inches.
 - 4. Maximum Slump for Concrete Containing High-Range Water-Reducing Admixture: 6 inches after admixture is added to concrete with 2- to 4-inch slump.
- D. Slab-on-Grade: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.42
 - 3. Minimum Cementitious Materials Content: 560 lb/cu. yd..
 - 4. Maximum Slump: 4 inches.
- E. Suspended Slabs: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.43
 - 3. Minimum Cementitious Materials Content: 550 lb/cu. yd..
 - 4. Maximum Slump: 4 inches.
- F. Cementitious Materials: For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements.
- G. Maximum Water-Cementitious Materials Ratio: 0.45 for concrete required to have low water permeability.
- H. Maximum Water-Cementitious Materials Ratio: 0.42 for concrete exposed to deicers or subject to freezing and thawing while moist.
- I. Maximum Water-Cementitious Materials Ratio: 0.42 for corrosion protection of steel reinforcement in concrete exposed to chlorides from deicing chemicals, salt, saltwater, brackish water, seawater, or spray from these sources.
- J. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated:
 - 1. Air Content: 6 percent for 3/4-inch- nominal maximum aggregate size.
- K. Do not air entrain concrete to trowel-finished interior floors and suspended slabs. Do not allow entrapped air content to exceed 3 percent.
- L. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) 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.

3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixes where indicated.

2.12 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 1. Class B, 1/4 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
 1. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. 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.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
1. Install anchor bolts, accurately located, to elevations required.
 2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

- A. General: 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 provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.
- B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved the following:
1. At least 70 percent of 28-day design compressive strength.
 2. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.
- C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- D. 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 exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

- A. Comply with ACI 318, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.

3.5 VAPOR RETARDERS

- A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.
- B. Fine-Graded Granular Material: Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.

3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain specified minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.
 2. All welded wire-fabric on slabs shall be supported by concrete bricks or chair supports at not more than 4'-0" on center each way.
 3. All reinforcing shall be securely tied prior to casting of concrete so as to avoid displacement of reinforcing. Contractor is responsible for ensuring that necessary measures are taken, whether shown in contract documents or not, to ensure that reinforcing is adequately tied and/or supported.
 4. "Laying in" of reinforcing during casting of concrete is not permitted.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. 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 D 3963/D 3963M.

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install 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. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 4. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated on drawings or if not shown, so as to divide slab into areas not in excess of 800 square feet. Form contraction joints as shown on Construction Drawings. Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Joints should be cut prior to initial cracking of concrete; or within 4- 12 hours of casting, depending on project conditions. As an alternate, contraction joints may be formed used molded inserts set prior to hardening of slab.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

- E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.
 - 1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's written instructions.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, 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.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 - 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators 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. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate. Do not vibrate forms or reinforcement.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

- F. 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 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. 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 or chemical accelerators, unless otherwise specified and approved in mix designs.
- G. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R 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 to 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.

3.10 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch in height.
- C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. 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. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
 2. Finish surfaces to the following tolerances according to ASTM E1155 for a randomly trafficked floor surface.
- C. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
 2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35; and levelness, F(L) 25, relative to specified slope; with minimum local values of flatness, F(F) 24; and levelness, F(L) 17, relative to specified slope; for slabs-on-grade.
- D. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- 3.12 MISCELLANEOUS CONCRETE ITEMS
- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 CONCRETE PROTECTION 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 recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed 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.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:
 - 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 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 not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.14 LIQUID FLOOR TREATMENTS

- A. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- B. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that

- penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- C. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- D. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 6. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days, two at 28 days and hold the fifth for possible future testing.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. Strength of each concrete mix will be satisfactory if every 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 shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall 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 mix 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 shall 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. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.

END OF SECTION 03 30 00

SECTION 04 20 10 – UNIT MASONRY, CMU Backup

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Concrete masonry units.
 - 2. Decorative concrete masonry units.
 - 3. Mortar and grout.
 - 4. Reinforcing steel.
 - 5. Masonry joint reinforcement.
 - 6. Ties and anchors.
 - 7. Miscellaneous masonry accessories.
- B. Related Sections include the following:
 - 1. Section 03300, Cast-in-Place Concrete
 - 2. Section 05120, Structural Steel
 - 3. Section 05210, Open Web Steel Joists
 - 4. Division 7, Bituminous Dampproofing
 - 5. Division 7, Water Repellents
 - 6. Division 7, Section Sheet Metal Flashing and Trim
 - 7. Division 7, Firestopping
- C. Products furnished, but not installed, under this Section include the following:
 - 1. Dovetail slots for masonry anchors, Section 03300, Cast-In-Place Concrete
 - 2. Adjustable masonry anchors welded to structural steel frame, Section 05120, Structural Steel
- D. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels for unit masonry
 - 2. Flashing reglets in masonry joists, Division 7

1.03 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops the following net-area compressive strengths (f'_m) at 28 days. Determine compressive strength of masonry by testing masonry prisms according to ASTM C 1314.
 - 1. For Concrete Unit Masonry: $f'_m = 1500$ psi.
- B. Masonry Grout: 3000 psi compressive strength at 28 days.

1.04 SUBMITTALS

- A. Comply with provisions of Section 01330.
- B. Product Data: For each different masonry unit, accessory, and other manufactured product specified.
- C. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
 - 2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- D. Samples for Verification: For the following:
 - 1. Full-size units for each different exposed masonry unit required, showing the full range of exposed colors, textures, and dimensions to be expected in the completed construction.

2. Colored mortar Samples for each color required, showing the full range of colors expected in the finished construction. Make samples using the same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
 3. Weep holes/vents in color to match mortar color.
 4. Accessories embedded in the masonry.
 - E. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
 1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents, unless such deviations are specifically brought to the attention of the Architect and approved in writing.
 - F. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
 - G. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
 1. Each type of masonry unit required.
 - a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
 - b. Include test results, measurements, and calculations establishing net-area compressive strength of masonry units.
 2. Mortar complying with property requirements of ASTM C 270.
 3. Grout mixes complying with compressive strength requirements of ASTM C 476. Include description of type and proportions of grout ingredients.
 - H. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 1. Each type of masonry unit required.
 - a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
 - b. Include test data, measurements, and calculations establishing net-area compressive strength of masonry units.
 2. Each cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
 3. Each combination of masonry unit type and mortar type. Include statement of net-area compressive strength of masonry units, mortar type, and net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
 4. Each material and grade indicated for reinforcing bars.
 5. Each type and size of joint reinforcement.
 6. Each type and size of anchor, tie, and metal accessory.
 - I. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.
 - J. Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with hot-weather requirements.
- 1.05 QUALITY ASSURANCE
- A. Comply with provisions of Section 01400.
 - B. Refer to architectural wall types and architectural drawings for additional information not provided in specifications.
 - C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1093 to conduct the testing indicated, as documented according to ASTM E 548.
 - D. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

- E. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
 - F. Preconstruction Testing Service: Engage a qualified independent testing agency to perform the following preconstruction testing:
 - 1. Concrete Masonry Unit Test: For each concrete masonry unit indicated, per ASTM C 140.
 - 2. Prism Test: For each type of wall construction indicated, per ASTM C 1314. Three total for entire project.
 - 3. Mortar Test: For mortar properties per ASTM C 270.
 - 4. Grout Test: For compressive strength per ASTM C 1019.
 - G. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.
 - H. Mockups: Before installing unit masonry, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Locate mockups in the locations indicated or, if not indicated, as directed by Architect.
 - 2. Build mockup of typical wall area as shown on Drawings.
 - 3. Build mockups for the following types of masonry in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wythes and accessories. Include a sealant-filled joint at least 16 inches long in each mockup.
 - a. Each type of exposed unit masonry construction.
 - b. Typical exterior wall.
 - c. Typical exterior wall with through-wall flashing installed for a 24-inch length in corner of mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Typical interior unit masonry wall.
 - 4. Clean exposed faces of mockups with masonry cleaner as indicated.
 - 5. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 - 6. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 7. Protect accepted mockups from the elements with weather-resistant membrane.
 - 8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 9. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, unless such deviations are specifically approved by Architect in writing.
 - 10. Demolish and remove mockups when directed.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Comply with Section 01600.
 - B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
 - 1. Protect Type I concrete masonry units from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.
 - C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

- D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.07 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 - 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required. Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

1.08 REFERENCE STANDARDS

- A. ACI 530/ASCE 5/TMS 402: Building Code Requirements for Masonry Structures
- B. ACI 530.1/ASCE 6/TMS 602: Specification for Masonry Structures
- C. ASTM A82: Standard Specification for Steel Wire Pland for Concrete Reinforcement
- D. ASTM C90: Standard Specification for Load bearing Concrete Masonry Units
- E. ASTM C144: Standard Specification for Aggregate for Masonry Mortar
- F. ASTM C150: Standard Specification for Portland Cement
- G. ASTM C207: Standard Specification for Hydrated Lime for Masonry Purposes
- H. ASTM C270: Standard Specification for Mortar for Unit Masonry
- I. ASTM C404: Standard Specification for Aggregates for Masonry Grout
- J. ASTM C476: Standard Specification for Grout for Masonry

- K. ASTM C780: Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
- L. ASTM C1019: Standard Test Method for Sampling and Testing Grout
- M. ASTM C1314: Standard Test Method for Compressive Strength of Masonry Prisms
- N. AWS D1.4: American Welding Society Structural Welding Code – Reinforcing Steel

PART 2 - PRODUCTS

- 2.01 See architectural wall types and architectural drawings for information not provided in specifications. Coordinate all requirements between drawings and specifications.
- 2.02 **CONCRETE MASONRY UNITS**
 - A. General: Provide shapes indicated and as follows:
 - 1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
 - 2. Provide bullnose units for outside corners, unless otherwise indicated.
 - B. Concrete Masonry Units (Decorative and Standard): ASTM C 90
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.
 - 2. Weight Classification: Normal weight, unless otherwise indicated.
 - 3. Provide Type I, moisture-controlled units.
 - 4. Exposed Faces: Manufacturer's standard color and texture, unless otherwise indicated.
- 2.03 **MORTAR AND GROUT MATERIALS**
 - A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 - B. Hydrated Lime: ASTM C 207, Type S.
 - C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207.
 - D. Mortar Cement: ASTM C 1329.
 - E. Masonry Cement: ASTM C 91.
 - 1. For pigmented mortar, use a colored cement formulation as required to produce the color indicated or, if not indicated, as selected from manufacturer's standard formulations.
 - 2. For colored-aggregate mortar, use natural color or white cement as necessary to produce required mortar color.
 - F. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 - 1. White-Mortar Aggregates: Natural white sand or ground white stone.
 - 2. Colored-Mortar Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
 - G. Aggregate for Grout: ASTM C 404.
 - H. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
 - I. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units (and approved for such use by manufacturer of the units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.
 - J. Water: Potable.
- 2.04 **REINFORCING STEEL**
 - A. Comply with reinforcing requirements in Section 03300, Cast-in-Place Concrete.
 - B. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M; Grade 60.
 - C. Epoxy-Coated Reinforcing Steel: ASTM A 615/A 615M, Grade 60; epoxy coated to comply with ASTM A 775/A 775M.

2.05 MASONRY JOINT REINFORCEMENT

- A. General: ASTM A 951 and as follows:
1. Hot-dip galvanized, carbon-steel wire for both interior and exterior walls.
 2. Wire Size for Side Rods: W2.8 or 0.188-inch diameter.
 3. Wire Size for Cross Rods: W2.8 or 0.188-inch diameter.
 4. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units where indicated.
- B. For single-wythe masonry, provide either ladder or truss type with single pair of side rods and cross rods spaced not more than 16 inches o.c.
- C. For multiwythe masonry, provide types as follows:
1. Ladder type with perpendicular cross rods spaced not more than 16 inches o.c. and 1 side rod for each face shell of hollow masonry units more than 4 inches in width, plus 1 side rod for each wythe of masonry 4 inches or less in width.
 2. Adjustable (2-piece) type with single pair of side rods and cross ties spaced not more than 16 inches o.c. and with separate adjustable veneer ties engaging the cross ties. Cross ties are either U-shaped with eyes or rectangular. Space side rods for embedment within each face shell of backup wythe and size adjustable ties to extend at least halfway through outer wythe but with at least 5/8-inch cover on outside face.
 - a. Use where indicated and where horizontal joints of facing wythe do not align with those of backup wythe.

2.06 TIES AND ANCHORS, GENERAL

- A. General: Provide ties and anchors, specified in subsequent articles, made from materials that comply with this Article, unless otherwise indicated.
- B. Hot-Dip Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.
- C. Steel Sheet, Galvanized after Fabrication: ASTM A 366/A 366M cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153.
- D. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.07 BENT WIRE TIES

- A. General: Rectangular units with closed ends and not less than 4 inches wide. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
1. Where coursing between wythes does not align, use adjustable ties composed of 2 parts; 1 with pintles, the other with eyes; with maximum misalignment of 1-1/4 inches.
- B. Wire: Fabricate from 3/16-inch- 1/4-inch- diameter, hot-dip galvanized steel wire.

2.08 ANCHORS FOR CONNECTING TO CONCRETE

- A. General: Provide two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section: Dovetail anchor section formed from 0.0528-inch- thick, steel sheet, galvanized after fabrication .
 2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.1875-inch- diameter, hot-dip galvanized steel wire.

2.09 RIGID ANCHORS

- A. General: Fabricate from steel bars as follows:
1. 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins.
 2. Finish: Hot-dip galvanized to comply with ASTM A 153.

2.10 ADJUSTABLE MASONRY-VENEER ANCHORS

- A. General: Provide two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

1. Anchor Section: Zinc-alloy barrel section with flanged head with eye and corrosion-resistant, self-drilling screw. Eye designed to receive tie section and to serve as head for drilling fastener into framing. Barrel length to suit sheathing thickness, allowing screw to seat directly against framing with flanged head covering hole in sheathing.
2. Wire Tie Section: Rectangular- shaped wire tie sized to extend at least halfway through veneer but with at least 5/8-inch cover on outside face.
3. Fabricate sheet metal anchor sections and other sheet metal parts from 0.0677-inch-thick, steel sheet, galvanized after fabrication .
4. Fabricate wire tie sections from 0.1875-inch- diameter, hot-dip galvanized steel wire.

2.11 MISCELLANEOUS ANCHORS

- A. Anchor Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of diameter and length indicated and in the following configurations:
 1. Headed bolts.
 2. Nonheaded bolts, bent in manner indicated.
- B. Postinstalled Anchors: Anchors as described below, with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 1. Type: Chemical anchors.
 2. Type: Expansion anchors only as noted on drawings.
 3. For Postinstalled Anchors in Concrete: Capability to sustain, without failure, a load equal to four times the loads imposed.

2.12 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from PVC.
- B. Preformed Control-Joint Gaskets: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches.
- E. Wicking Material: Cotton or polyester rope, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity between wythes.
- F. Plastic Weep Hole/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, designed to fill head joint with outside face held back 1/8 inch from exterior face of masonry, in color selected from manufacturer's standard.
- G. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication.

2.13 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.
- B. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.14 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification.
 - 1. For masonry below grade, in contact with earth, and where indicated, use Type M.
 - 2. For reinforced masonry and where indicated, use Type S.
 - D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates combined with selected cementitious materials.
 - 1. Mix to match Architect's sample.
 - E. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 5 of ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 - 2. Provide grout with a slump of 9 inches (+/- one inch) as measured according to ASTM C 143.
 - F. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's directions.
- 2.15 SOURCE QUALITY CONTROL
- A. Owner will engage a qualified independent testing agency to perform source quality-control testing indicated below:
 - 1. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.
 - B. Brick Tests: For each type and grade of brick indicated, units will be tested according to ASTM C 67.
 - C. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.02 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specifications.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.
- D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

3.03 CONSTRUCTION TOLERANCES

- A. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:
- B. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.
- C. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, nor 1/2 inch maximum.
- D. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.
- E. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.04 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
 - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
 - 2. As indicated on Drawings.
- C. Stopping and Resuming Work: In each course, rack back one-half-unit length for one-half running bond or one-third-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.
- D. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
- E. Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.
- F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.
- G. Fill cores in hollow concrete masonry units with grout 24 inches under anchor bolt locations unless otherwise indicated.

3.05 MORTAR BEDDING AND JOINTING

- A. Lay hollow masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.
 - 2. Bed webs in mortar.
 - 3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
 - 4. At cavity walls, bevel beds away from cavity, to minimize mortar protrusions into cavity. As work progresses, trowel mortar fins protruding into cavity flat against the cavity face of the brick.

3.06 CAVITIES

- A. Keep cavities clean of mortar droppings, debris, and other materials during construction. Strike joints facing cavities flush.
 - 1. Use wood strips temporarily placed in cavity to collect mortar droppings. As work progresses, remove strips, clean off mortar droppings, and replace in cavity.
- B. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
 - 1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.07 MASONRY JOINT REINFORCEMENT

- A. General: Provide continuous masonry joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches. Space reinforcing a maximum of 16" on center.
- B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.08 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
 - 1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar or other rigid materials.
 - 2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 16 inches o.c.

3.09 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to concrete and masonry backup with seismic masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten each anchor section with two metal fasteners of type indicated.
 - 2. Space anchors as indicated, but not more than 16 inches o.c. vertically and 16 inches o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around the perimeter.

3.10 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joints in unit masonry where indicated or a maximum of 25 feet on center. Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 - 1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake joints in exposed faces.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake joint.

3.11 LINTELS

- A. Install steel lintels where indicated or as required for masonry openings shown on drawings. Lintel sizes to be sufficient to support weight of masonry and deflection requirements.
- B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
 - 1. Provide prefabricated or built-in-place masonry lintels. Use specially formed bond beam units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.12 FLASHING, WEEP HOLES, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

- B. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Unless otherwise indicated, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 1. Cut flashing off flush with face of wall after masonry wall construction is completed.
 - C. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing and as follows:
 - 1. Use rectangular plastic tubing, plastic weep hole/vents, or vinyl weep hole/vents, to form weep holes.
 - 2. In cavities, place pea gravel to a height equal to height of first course, but not less than 2 inches, immediately above top of flashing embedded in the wall, as masonry construction progresses, to splatter mortar droppings and to maintain drainage.
- 3.13 REINFORCED UNIT MASONRY INSTALLATION
- A. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.
 - 1. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
 - B. Placing Reinforcement: Comply with requirements of ACI 530.1/ASCE 6/TMS 602.
 - C. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
 - 1. Comply with requirements of ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
- 3.14 FIELD QUALITY CONTROL
- A. Owner will engage a qualified independent testing agency to perform field quality-control testing indicated below.
 - 1. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.
 - B. Testing Frequency: Tests and Evaluations listed in this Article will be performed during construction for each 5000 sq. ft. of wall area or portion thereof.
 - C. Mortar properties will be tested per ASTM C 780.
 - D. Grout will be sampled and tested for compressive strength per ASTM C 1019.
 - E. Brick Tests: For each type and grade of brick indicated, units will be tested according to ASTM C 67.
 - F. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.
 - G. Prism-Test Method: For each type of wall construction indicated, masonry prisms will be tested per ASTM C 1314, and as follows:
 - 1. Two prisms for the All-Purpose Room
 - 2. Two prisms for all other masonry.
- 3.15 REPAIRING, POINTING, AND CLEANING
- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
 - B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing the surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.16 MASONRY WASTE DISPOSAL

- A. Recycling: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Disposal as Fill Material: Dispose of clean masonry waste, including broken masonry units, waste mortar, and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
- C. Excess Masonry Waste: Remove excess, clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 81 00

SECTION 05 12 00 - STRUCTURAL STEEL**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Structural steel.
 - 2. Base, leveling, and bearing plates.
 - 3. Architecturally exposed structural steel.
 - 4. Grout.
- B. Work Furnished but Installed by Others
 - 1. Anchorages cast into concrete and masonry.
 - 2. Lintels installed in masonry.
- C. Related Sections include the following:
 - 1. Division 3, Cast-In-Place Concrete
 - 2. Division 4, Unit Masonry Assemblies
 - 3. Division 5, Open Web Steel Joists
 - 4. Division 5, Steel Deck
 - 5. Division 9, Painting

1.03 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
- B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents or shown as exposed through the use of building sections, wall sections, and elevations.

1.04 REFERENCE STANDARDS

- A. AISC – Manual of Steel Construction, Allowable Stress Edition, 9th Edition
- B. AISC – Code of Standard Practice for Steel Buildings and Bridges
- C. AISC – Specification for Structural Joints using ASTM A325 or A490 Bolts
- D. ASTM A6 – General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for structural use
- E. ASTM A36 – Carbon Structural Steel
- F. ASTM A53 – Welded and Seamless Steel Pipe

- G. ASTM A108 – Steel Bars, Carbon, Cold Finished Standard Quality
- H. ASTM A123 – Zinc Hot Galvanized Coatings on Iron and Steel Products
- I. ASTM A242 – High-Strength Low-Alloy Structural Steel
- J. ASTM A307 – Carbon Steel Bolts and Studs
- K. ASTM A325 – High Strength Bolts for Structural Steel Joints, including Suitable Nuts and Plain Hardened Washers
- L. ASTM A434 – Steel Bars, Alloy, Quenched and Tempered
- M. ASTM A449 – Quenched and Tempered Steel Bolts and Studs
- N. ASTM A490 – Heat Treated Structural Steel Bolts
- O. ASTM A500 – Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- P. ASTM A501 – Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
- Q. ASTM A992 – Standard Specification for Steel for Structural Shapes For Use in Building Framing
- R. ASTM 1008 - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
- S. ASTM 1011 – Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
- T. ASTM C1107 – Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
- U. AWS – Standard Qualification Procedure
- V. AWS A2.4 – Standard Symbols for Welding, Brazing, and Non-destructive Examination
- W. AWS – D1.1 – Structural Welding Code
- X. OSHA 1926 29 CFR – Safety and Health Regulations for Construction
- Y. SSPC SP-2 – Hand Tool Cleaning
- Z. SSPC SP-3 – Power Tool Cleaning

1.05 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear and moment resisting connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.
 - 1. Select and complete connections using schematic details indicated and AISC's "Manual of Steel Construction, Allowable Stress Design," Part 4.
 - 2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer registered in the State of RI to prepare structural analysis data for moment resisting beam to column structural-steel connections. Analysis to be stamped and signed.
- B. Construction: Type 1 and 2, simple span and fully rigid framing.

1.06 SUBMITTALS

- A. Comply with provision in Division 1. Submit a maximum of four sets.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
 5. Include moment resisting structural-steel connections to be in compliance with design loads. Provide complete structural analysis data, signed and sealed by the qualified professional engineer responsible for their preparation who is licensed in the State of Rhode Island. Both the moment and shear components of the connection are to be included in the analysis.
- D. Welding certificates.
- E. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
1. Structural steel including chemical and physical properties.
 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 3. Direct-tension indicators.
 4. Tension-control, high-strength bolt-nut-washer assemblies.
 5. Shear stud connectors.
 6. Shop primers.
 7. Nonshrink grout.
- F. Source quality-control test reports.
- G. Submit data on shop primer indicating adhesion compatibility with spray on fireproofing.
- 1.07 QUALITY ASSURANCE
- A. Comply with provisions in Division 1.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Cbd.
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel."
- E. Comply with applicable provisions of the following specifications and documents:
1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
 3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
 4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
 5. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
 6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- F. Mockups: Build mockups of architecturally exposed structural steel to set quality standards for fabrication and installation.
1. Coordinate finish painting requirements with Division 9 painting Sections.
 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 01310 - Project Management and Coordination.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Comply with provisions in Division 1.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- C. Deliver materials to the site at such intervals to ensure uninterrupted progress of the work.

1.09 COORDINATION

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992 or ASTM A 572, Grade 50.
- B. Channels, Angles, M, S-Shapes: ASTM A 36.
- C. Plate and Bar: ASTM A 36.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- E. Steel Pipe: ASTM A 53, Type E or S, Grade B.
- F. Medium-Strength Steel Castings: ASTM A 27, Grade 65-35, carbon steel.
- G. High-Strength Steel Castings: ASTM A 148, Grade 80-50, carbon or alloy steel.
- H. Welding Electrodes: E70xx, comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 or ASTM A 490, Type 1, heavy hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers, plain.
 - 1. Finish: Plain.
 - 2. Direct-Tension Indicators: ASTM F 959, compressible-washer type
 - 3. Tension-Control Assemblies: ASTM F 1852
- B. Unheaded Anchor Rods: ASTM A 307, Grade A.

1. Configuration: Hooked.
2. Nuts: ASTM A 563 hex carbon steel.
3. Plate Washers: ASTM A 36 carbon steel.
4. Washers: ASTM F 436 hardened carbon steel.
5. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.

- C. Threaded Rods: ASTM A 193.
1. Nuts: ASTM A 563 hex carbon steel.
 2. Washers: ASTM A 36 carbon steel.
 3. Finish: Plain.

2.03 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer when used without fireproofing materials.
- B. When intumescent is specified, primer paint is to be compatible.
- C. Galvanizing Repair Paint: ASTM A 780, minimum 95% metallic zinc by weight.
- D. Steel exposed to exterior weather is to have high performance coating system or be hot dipped galvanized.

2.04 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.05 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
1. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
 2. Mark and match-mark materials for field assembly.
 3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.
1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.
 2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning and SSPC-SP 3, "Power Tool Cleaning."
- F. Holes:
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Base-Plate Holes: Cut, drill, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- G. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- I. Fabricate beams and girders with positive camber when composite with the concrete slab. Prescribe enough camber to counteract dead load of concrete slab and framing. Amount of camber is to be indicated on submitted shop drawings.

2.06 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Pretensioned.
- B. Weld Connections: E70xx in compliance with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 - 2. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.07 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123.
 - 1. Galvanize loose lintels and relieving angles attached to structural-steel frame and located in exterior walls.
 - 2. Galvanize steel as noted on drawings.

2.08 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
 - 1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set bearing and leveling plates for structural members on leveling grout as required.
 - 2. Pretension anchor rods after supported members have been positioned and plumbed.
 - 3. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection.
- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Touch-up Painting: immediately after erection, clean field welds, bolted connections, and abraded areas of the shop paint. Apply paint to exposed areas with the same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils. Use galvanizing repair paint to correct damaged or abraded areas of galvanized members and to cover and protect field welds in galvanized members

3.04 FIELD CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Pretensioned.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: All field welds will be visually inspected according to AWS D1.1.
 1. In addition to visual inspection, 10% of all field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.
- D. Any field alterations are to be submitted as a drawing to the architect prior to implementation. Submitted drawing is to show field conditions and work to be performed including, but not

limited to member sizes, tolerances, weld sizes and length, and connection information.
Proposed field alteration is subject to approval by architect or engineer.

END OF SECTION 05 12 00

SECTION 05 31 00 - METAL DECK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Roof deck.
 - 2. Deck accessories, closures, fillers, fastening of deck.
 - 3. Roof frames
- B. Related Sections include the following:
 - 1. Division 3, Cast-in-Place Concrete
 - 2. Division 4, Unit Masonry Assemblies
 - 3. Division 5, Structural Steel
 - 4. Division 5, Open Web Steel Joists
 - 5. Division 7, Roof Insulation

1.03 SUBMITTALS

- A. Comply with provisions in Division 1.
- B. Submit a maximum of four sets. Contractor to make sepias of reviewed sets as required for further distribution.
- C. Product Data: For each type of deck, accessory, and product indicated.
- D. Shop Drawings:
 - 1. Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction. Include dimensions of individual components and finishes.
 - 2. Type and location of welds.
 - 3. Details of accessories, showing sump pans, cant strips, closure strips and insulation supports.
- E. Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements. Include test reports for mechanical fasteners showing compliance with required loading.
- F. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.04 QUALITY ASSURANCE

- A. Comply with provisions in Division 1.
- B. Manufacturer Qualifications: Member of the Steel Deck Institute.
- C. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- E. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

- F. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
 - 3. Finish of steel deck is to provide adequate adhesion for spray on fire resistant material.
- G. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with provisions in Division 1.
- B. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- C. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
- D. Do not place bundles of deck on unstable structural members or in such a manner that will overstress the supporting beam, joist, or wall.

1.06 COORDINATION

- A. Coordinate deck penetrations with other trades as required. Any opening to be shown on shop drawings.
- B. Coordinate roof frame quantities, locations, and dimensions with other trades as required. Structural steel roof frames to be provided as noted in Article 3.

1.07 REFERENCE STANDARDS

- A. AISI – Specification for the Design of Cold-Formed Steel Structural Members with Commentary
- B. ASTM A36 – Carbon Structural Steel
- C. ASTM A108 – Steel Bars, Carbon Cold-Finished Standard Quality
- D. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- E. ASTM A446 – Steel Sheet, zinc coated by the Hot-Dip Process, Structural Quality
- F. ASTM A525 – Steel Sheet, zinc coated by the Hot-Dip Process, General Requirements
- G. ASTM A653 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- H. ASTM A1008 – Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
- I. AWS D1.1 – Structural Welding Code – Steel
- J. AWS D1.3 – Structural Welding Code - Sheet Steel
- K. MIL – MIL-P-21035, Galvanizing Repair
- L. OSHA 1926 29 CFR – Safety and Health Regulations for Construction
- M. SDI – Publication No. 29, Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Floor Deck Systems with Electrical Distribution
- N. SDI DDM02 – Diaphragm Design manual; Steel Deck Institute, Inc.; 2nd Edition.

PART 2 - PRODUCTS

2.01 NON-COMPOSITE FORM DECK

- A. Non-composite Steel Form Deck: Fabricate ribbed-steel sheet noncomposite form deck panels to comply with "SDI Specifications and Commentary for Non-composite Steel Form Deck," in SDI Publication No. 29, the minimum section properties indicated, and the following:

METAL DECK

1. Galvanized Steel Sheet: ASTM A 653, Structural Steel, Grade 33, G60 zinc coating.
2. Profile Depth: 1 1/2 inches.
3. Design Uncoated-Steel Thickness: 20 gauge.
4. Span Condition: Triple span or more.
5. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.02 COMPOSITE FLOOR DECK

- A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 29, the minimum section properties indicated, and the following:
1. Galvanized Steel Sheet: ASTM A 653, Structural Steel, Grade 33, G60 zinc coating.
 2. Profile Depth: 1 1/2 inches.
 3. Design Uncoated-Steel Thickness: 20 gauge or as noted in plans
 4. Span Condition: Triple span or more.

2.03 ROOF DECK

- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29, and the following:
1. Galvanized Steel Sheet: ASTM A 653, Structural Steel, Grade 33, G90 zinc coating.
 2. Deck Profile: Type B wide rib.
 3. Profile Depth: 1 1/2 inches or 1 inch.
 4. Design Uncoated-Steel Thickness: 18 gage or 20 gage or as noted in plan
 5. Span Condition: Triple span or more.
 6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.04 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Steel Sheet Accessories: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- G. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated unless noted otherwise on drawings.
- H. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated

- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.
- J. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- K. Shear Connectors: ASTM A 108, Grades 1010 through 1020 headed stud type, cold-finished carbon steel, AWS D1.1, Type B, with arc shields
- L. Galvanizing Repair Paint: ASTM A 780.
- M. Repair Paint: Lead- and chromate-free rust-inhibitive primer complying with performance requirements of FS TT-P-664.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.02 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 29, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
- C. Locate decking bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to decking.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.03 ROOF DECK INSTALLATION

- A. Fasten roof deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter, but not less than 1-1/2 inches long, and as follows:
 - 1. Weld Diameter: 5/8 inch, nominal.
 - 2. Weld Spacing: Weld deck in place at all supports with a 3/4 pattern with additional welds spaced at 6 inches apart at the perimeter of the building and roof corners. Welding to be less than a minimum of two welds per deck unit at each support or 12 inches on-center in the field.
 - 3. Weld Washers: Install weld washers at each weld location as recommended by SDI.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/3 of the span or 36 inches, and as follows:
 - 1. Mechanically fasten with self-drilling No. 10 diameter or larger carbon-steel screws.
 - 2. Fasten with a minimum of 1-1/2-inch- long welds.
 - 3. Minimum of two fasteners for each deck span.

- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped 2 inches minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof decking and weld flanges to top of deck. Space welds not more than 12 inches apart with at least 1 weld at each corner.
- E. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
- G. Reinforcement at Openings: Reinforce any opening penetrating metal deck shown on the contract documents as follows unless noted otherwise on drawings:
 - 1. Openings with any dimension 8" or less to have a flat steel plate welded to the top surface of the deck. Plate to extent 12" past the opening in each direction and to be minimum 18 gauge. Weld or screw plate to deck at 3 locations each side.
 - 2. Openings greater than 8" in any direction to be reinforced with a structural steel angle frame. Frame to support the entire perimeter of opening and to be supported on each end by adjacent framing or load bearing wall. Unless noted otherwise frame to be constructed of L3x3x1/4 angles.

3.04 FLOOR DECK INSTALLATION

- A. Fasten floor deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: 5/8 inch, nominal.
 - 2. Weld Spacing: Weld edge ribs of panels at each support. Space welds 12 inches apart in the field of the floor and 6 inches apart at any perimeter edge.
 - 3. Weld Washers: Install weld washers at each weld location as recommended by SDI.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/3 of the span or 36 inches, and as follows:
 - 1. Mechanically fasten with self-drilling No. 10 diameter or larger carbon-steel screws.
 - 2. Fasten with a minimum of 1 1/2 inch long welds
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
 - 1. End Joints: Lapped.
- D. Shear Connectors: Weld shear connectors through deck to supporting frame according to AWS D1.1 and manufacturer's written instructions. Butt end joints of deck panels; do not overlap. Remove and discard arc shields after welding shear connectors
- E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.
- F. Floor Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides

of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.

- G. Install piercing hanger tabs not more than 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides, unless otherwise indicated.
- H. Reinforcement at Openings: Reinforce any opening penetrating floor deck shown on contract documents with structural steel angle frame. Frame is to support entire perimeter of openings and will bear on framing or load bearing wall on each side. Unless noted otherwise members of frame are to be built from L4x4x1/4 angles.

3.05 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing agency to perform field quality-control testing.
- B. Field welds will be subject to inspection.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.06 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
 - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 - 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 9, Painting.
- C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 31 00

SECTION 05 50 00 - METAL FABRICATIONS

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. DESCRIPTION OF THE WORK:
1. The extent of metal fabrication work is shown and includes items fabricated from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not part of structural steel or other metal systems in other sections of these specifications. Such work includes but is not limited to:
 2. Section Includes:
 - a. Miscellaneous steel framing and supports.
 - c. Shelf angles.
 - e. Metal ladders.
 - f. Metal grating
 - g. Structural-steel door frames.
 - h. Abrasive metal nosings and thresholds.
 - i. Miscellaneous steel trim.
 - j. Bollards.
 - k. Downspout guards.
 - n. Bolts, anchors, nuts, washers, fastening devices, etc.
 - o. Pipe sleeves not specified in other sections.
 - p. Miscellaneous structural steel, metals and supports, including shelf angles, loose bearing plates, lintels, steel trim, framing and supports.
 - q. Ladder to roof.
 - r. Ladder safety cages.
 - s. Ladder to elevator pit
 - t. Floor steel plate.
 - u. Stainless steel panels for countertops and backsplashes.
 - v. Overhead door frames
- C. Products furnished, but not installed, under this Section:
1. Loose steel lintels.
 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 3. Steel weld plates and angles for casting into concrete.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

- C. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.3 RELATED WORK UNDER OTHER SECTIONS;

- A. Division 05 Section Structural Steel.
- B. Division 05 Section Metal Decking.
- C. Division 05 Section Cold-Formed Metal Framing.
- D. Division 05 Section Handrails and Railings.
- E. Division 07 Sections for Roofing Systems
- F. Division 08 Sections for Overhead Door
- G. Division 08 Section Louvers.
- H. Division 09 Section Painting

1.4 QUALITY ASSURANCE;

- A. Code and Standards:
 - 1. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including "Commentary of the AISC Specifications".
 - 2. AISC "Specification for the Design of Cold-Formed Steel Structural Members".
 - 3. AWS "Structural Welding Code".
- B. Qualification for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure". Welding operators shall be qualified in accordance with Section 05 of AWS D1.1 Qualification records shall be maintained at the site for review by the Inspection Agency representative and the Architect, when requested.
- C. 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 wherever taking field measurements before fabrication might delay work.
- D. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of miscellaneous metal work. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.
 - 1. See concrete and masonry sections of these specifications for installation inserts and anchorage devices.
- E. Shop Assembly: Pre-assemble items in 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.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Metal nosings and treads.

2. Paint products.
 3. Grout.
- B. Manufacturer's Data: For information only, submit copies of manufacturer's specifications, anchor details and installation instructions for products to be used in the fabrication of miscellaneous metal work, including paint products. Transmit copy of instructions to Installer.
- C. Shop Drawings: Submit shop drawings for fabrication and erection of miscellaneous metal assemblies. Include plans and elevations at not less than 1" to 1'-0" scale, and include details of sections and connections at not less than 3" to 1'-0" scale. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others.
- D. Samples: For each type and finish of extruded nosing and tread.
- E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

2.2 FERROUS METALS

- A. Metal Surfaces, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trades names and roughness.
- B. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent
- C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- E. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- F. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
- G. Abrasive-Surface Floor Plate: Steel plate with abrasive material metallurgically bonded to steel.
- H. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- I. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
- J. 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 and/or as indicated.
 2. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B, with G90 coating; 0.108-inch nominal thickness.
 3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B; 0.0966-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel or hot-dip galvanized after fabrication for exterior applications.
- K. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M.

2.3 NONFERROUS METALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- B. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- C. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
- D. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
- E. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).
- F. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze)

2.4 ANCHORS:

- A. Threaded-Type Concrete Inserts: Galvanized ferrous castings, internally threaded to receive 3/4" diameter machine bolts; either malleable iron complying with ASTM A 47 or cast steel complying with ASTM A 27; hot dipped galvanized.
- B. Wedge-Type Concrete Inserts: Galvanized box-type ferrous castings, designed to accept 3/4" diameter bolts having special wedge-shaped heads; either malleable iron complying with ASTM A 47 or cast steel complying with ASTM A 27; hot dipped galvanized.
 - 1. Provide carbon steel bolts having special wedge-shaped heads, nuts, washers and shims; all galvanized in compliance with ASTM A 153.
- C. Slotted-Type Concrete Inserts: Galvanized 1/8" thick pressed steel plate complying with ASTM A 283; box-type welded construction with slot designed to receive 3/4" diameter square head bolt and with knockout cover; hot dipped galvanized.

2.5 FASTENERS

- A. General: Provide zinc-coated fasteners, with galvanizing complying with ASTM A 153, for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required for the installation of miscellaneous metal items.
 - 1. Standard Bolts and Nuts: ASTM A 307, Grade A, regular hexagon head.
 - 2. Lag Bolts: FS FF-B-561, square head type.
 - 3. Machine Screws: FS FF-S-92, cadmium plated steel.
 - 4. Wood Screws: FS FF-S-111, flat head, carbon steel.
 - 5. Plain Washers: FS FF-W-92, round general assembly, grade carbon steel.
 - 6. Lock Washers: FS FF-W-84, helical spring type, carbon steel.
 - 7. Masonry Anchorage Devices: Expansion shields, FS FF-S-325.
 - 8. Toggle Bolts: Tumble-wing type; FS FF-B-588, type, class and style as required.
- B. 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 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
 - 2. Provide stainless-steel fasteners for fastening stainless steel.
 - 3. Provide stainless-steel fasteners for fastening nickel silver.
 - 4. Provide bronze fasteners for fastening bronze.
- C. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

- D. 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 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
 2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy [**Group 1 (A1)**] [**Group 2 (A4)**] stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
- E. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) 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.

2.6 PAINT:

- A. Metal primer Paint: Primer selected must be compatible with finish coats of paint. Coordinate selection of metal primer with finish paint requirements specified in Division 09.
- B. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel, complying with Military Specification MIL-P-21035 (Ships).
1. Product conforming to above specification: ZRC cold galvanizing compound.
- C. Where galvanizing prior to completing fabrication cannot be avoided, joints shall be welded after fabrication, ground smooth and finished with four (4) full coats of California Products Corp. WW Totrust, Sealube ZRC, ZIRP by Duncan Galvanizing or approved equal.

2.7 FABRICATION, GENERAL

- A. Workmanship: Use materials of size and thickness shown or, if not shown, of required size and thickness to produce strength and durability in finished product. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use type of materials shown or specified for various components of work.
- B. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
- C. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32" unless otherwise shown. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Weld corners and seams continuously, complying with AWS recommendations. Grind exposed welds smooth and flush, to match and blend adjoining surfaces.
- E. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type shown or, if not shown, Phillips flat-head (countersunk) screws or bolts.
- F. Provide for anchorage of type shown, coordinated with supporting structure. Fabricate and space anchoring devices as shown and as required to provide adequate support for intended use.
- G. Cut, reinforce, drill and tap miscellaneous metal work as required to receive finish hardware and similar items.
- H. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

- I. Galvanizing: provide a hot-dip zinc coating, with the addition of 0.05 – 0.09% Nickel to the zinc bath, for those items supporting or built-into exterior masonry or concrete, steel items exposed to the weather, and other items shown or specified to be galvanized, as follow:
 - 1. ASTM A 153 for galvanizing iron and steel hardware.
 - 2. ASTM A 123 for galvanizing rolled, pressed and forged steel shapes, plate, bars and strip 1/8" thick and heavier.
 - 3. After pickling and prior to galvanizing, the steel shall be immersed in a bath of zinc ammonium chloride. The dry kettle process shall be used to eliminate any flux inclusions on the surface of the galvanized material.
- J. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- K. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors as indicated. If not indicated, at not more than 24 inches o.c. maximum spacing.
- L. Shop Painting:
 - 1. 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, and galvanized surfaces, unless otherwise specified.
 - 2. Remove scale, rust and other deleterious materials before applying shop coat. Clean off heavy rust and loose mill scale in accordance with SSPC SP-2 "Hand Tool Cleaning", or SSPC SP-3 "Power Tool Cleaning", or SSPC SP-7 "Brush-off Blast Cleaning".
 - 3. Remove oil, grease and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning".
 - 4. Apply one shop coat of metal primer paint to fabricated metal items, except apply two coats of paint to surfaces inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.
 - 5. Immediately after surface preparation, brush or spray on metal primer paint, applied in accordance with manufacturer's instructions, and at a rate to provide uniform dry film thickness of 1.5 mils for each coat. Use painting methods which will result in full coverage of joints, corners, edges and exposed surfaces.
 - 6. Where painting of galvanized steel is indicated, provide factory-applied polyamide epoxy primer, 2.0 milsDFT, minimum, in preparation for field applied topcoat. Apply primer within twelve hours after galvanizing at the galvanizer's plant in a controlled environment meeting applicable environmental regulations, and as recommended by the coating manufacturer.
 - a. Provide Duncan PrimerGalv for all galvanized surfaces indicated to be field painted.
 - 7. Shop Marking: When shop markings are utilized on metal items for the convenience of the fabricator, or installer, use marking devices which are compatible to the subsequent paint coatings; otherwise remove markings upon installation and prepare surfaces for their finish coatings.

2.8 MISCELLANEOUS METAL FABRICATIONS:

- A. Rough Hardware:
 - 1. Furnish bent or other custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware are specified in Division 06.

2. Manufacture or fabricated items of sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.
- B. Loose Bearing Plates:
1. Provide for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area, as indicated. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.
- C. Loose Steel Lintels:
1. Provide loose structural steel shape lintels for openings and recesses in masonry walls and partitions as shown. Weld adjoining members together to form a single unit. Provide not less than 6" bearing at each side of openings, unless otherwise shown.
 - a. Galvanize loose steel lintels to be installed at exterior walls.
- D. Miscellaneous Framing and Supports:
1. Provide miscellaneous steel framing and supports which are not a part of structural steel framework, as required to complete work.
 2. Reinforce openings through steel deck, greater than 12" x 12" (144 sq. in.), with angle framing as detailed, and indicated on the Structural Drawings.
 3. Fabricate miscellaneous units to sizes, shapes and profiles shown or, if not shown, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.
 4. Equip units with integrally welded anchor straps for casting into poured concrete or building into masonry wherever required. Furnish inserts if units must be installed after concrete is placed. Except as otherwise shown, space anchors 24" o.c. and provide minimum anchor units of 1-1/4" x 1/4" x 8" steel straps.
 - a. Galvanize exterior miscellaneous frames and supports.
 5. Miscellaneous Steel trim:
 - a. Galvanize exterior miscellaneous steel trim.
- 2.9 MISCELLANEOUS MATERIALS
- A. Low-Emitting Materials: Paints and coatings 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. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

- H. Concrete: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3,000 psi (20 MPa) minimum.
- I. At protection bollards provide 1/8" nominal wall thickness polyethylene thermoplastic (HDPE) covers where indicated

2.10 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19 mm) bolts, spaced not more than 6-inches (150 mm) from ends and 24-inches (600 mm) o.c., unless otherwise indicated.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize shelf angles located in exterior walls.
- D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.11 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.
- C. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
 - 1. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches (600 mm) o.c.
- D. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.12 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize shelf angles located in exterior walls.
- D. Prime shelf angles located in exterior walls with zinc-rich primer or primer specified in Division 09 Section "High-Performance Coatings."
- E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.13 GRATINGS

- 1. General:
 - a. Design is based upon use of carbon steel gratings as manufactured by Ohio Gratings, Inc. and terminology used herein may include reference to the specific

performance or product of this manufacturer. Such reference shall be construed only as establishing the quality of materials, operational features and workmanship to be used under this Section and shall not, in any way, be construed as limiting competition.

2. Grating: Heavy Duty Welded Steel W Series by Ohio Gratings Inc., or equal.
3. Bearing Bars: Rectangular bar 2" depth x 3/8" width minimum on a maximum of 15/16" centers. Design system to support H-20 loading.
4. Cross Bars: To be welded at right angles to bearing bars at 4" centers maximum.
5. Surface: Serrated.
6. Loading: Minimum H-20.
7. Finish: The gratings shall be provided galvanized after fabrication.
8. Fabrication and Tolerances shall be in accordance with ANSI/ NAAMM Metal Bar Grating Manual.

2.14 METAL LADDERS

A. General:

1. Comply with ANSI A14.3 unless otherwise indicated.
2. For elevator pit ladders, comply with ASME A17.1.
3. Comply with OSHA standards 1910 and 1926

B. Aluminum Ladders:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. ACL Industries, Inc.
 - b. Alco-Lite Industrial Products.
 - c. Halliday Products.
 - d. O'Keeffe's Inc.
 - e. Precision Ladders, LLC.
 - f. Royalite Manufacturing, Inc.
 - g. Thompson Fabricating, LLC.
2. Space siderails 24 inches (457 mm) apart unless otherwise indicated.
3. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
4. Rungs: Extruded-aluminum tubes, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, with ribbed tread surfaces.

C. Interior Steel Ladders:

1. Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with the requirements of ANSI A14.3, except as otherwise indicated.
2. Side Rails: 3" x 5 lb. continuous structural steel flat channel; spaced 18" apart, unless shown otherwise.
3. Rungs: 1" square structural steel rungs, manufactured by SlipNot, spaced 12" o.c.
 - a. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
 - b. Non-Slip Surface: Average peak to valley surface depth of 0.020 – 0.025", equal to SlipNOT Grade 2 (Medium)
4. Support each ladder at top and bottom and at intermediate points spaced not more than 5'-0" o.c. Use welded or bolted steel brackets, designed for adequate support and anchorage and to hold the ladder clear of the wall surface with a minimum of 7" clearance from wall to centerline of rungs. Extend rails 42" above top rung, and return rails to wall

or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.

5. Galvanize all elevator pit and/or other below ground floor pit ladders after fabrication.

D. Exterior Steel Ladders.

1. Fabricate ladders similar to interior ladders.
 - a. Galvanize all exterior steel fabrications after fabrication.
2. At Contractor option: Provide prefabricated aluminum metal ladders from manufactures listed above under Aluminum Ladders.

2.15 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.
- C. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
 1. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches o.c.
- D. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.16 STRUCTURAL-STEEL DOOR FRAMES

- A. Fabricate structural-steel door frames from steel shapes fully welded together, with 5/8-by-1-1/2-inch steel channel stops. Plug-weld built-up members and continuously weld exposed joints. Reinforce frames and drill and tap as necessary to accept finish hardware.
 1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
- B. Galvanize exterior steel frames.
- C. Prime interior steel frames with zinc-rich primer for field paint unless indicated as 'galvanized'.

2.17 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
- C. Galvanize exterior miscellaneous steel trim.

2.18 METAL BOLLARDS

- A. Fabricate metal bollards from 1/4-inch wall-thickness rectangular steel tubing or steel shapes, as indicated.
 - 1. Cap bollards with 1/4-inch-thick steel plate.
 - 2. Concrete fill bollards at all vehicle door openings unless noted otherwise.
- B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting when indicated to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.
- C. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch thick steel plate welded to bottom of sleeve.
- D. Galvanize ALL exterior bollards and the interior bollards where indicated.
- E. Provide 1/8" nominal wall thickness polyethylene thermoplastic (HDPE) covers where indicated

2.19 PIPE DOWNSPOUT GUARDS

- A. Fabricate pipe downspout guards from 3/8-inch-thick by 12-inch-wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch (50-mm) clearance between pipe and pipe guard. Drill each end for two 3/4-inch (19-mm) anchor bolts.
- B. Galvanize pipe downspout guards.

2.20 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.21 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Galvanize loose steel lintels located in exterior walls.

2.22 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.23 STAINLESS STEEL SHEET

- A. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 316, stretcher-leveled standard of flatness.
 - 1. Stainless-Steel Sheet: 0.050 inch, minimum thickness recommended to comply with performance requirements for applications indicated.
 - a. Finish: No. 4, unless otherwise selected.

2.24 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Finish metal fabrications after assembly.

2.25 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.
- 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 universal shop primer or primers specified in Division 09 painting Sections unless zinc-rich primer is indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Items Indicated to Receive Primers Specified in Division 09 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 4. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine the areas and conditions under which miscellaneous metal items are to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 PREPARATION:

- A. Furnish setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.3 INSTALLATION:

- A. Setting Loose Bearing Plates:
 - 1. Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean the bottom surface of bearing plates.
 - 2. Set loose bearing plates on wedges, or other adjustable devices. After the joints have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with the edge of the bearing plate before packing with mortar.
 - 3. Pack bedding mortar solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 GALVANIZING:

- A. Completely clean interior as well as exterior surfaces and coat with zinc. Provide vent holes for air and frothy fluxes to be allowed to flow upward and completely out; cleaning solutions and molten zinc must be allowed to flow in and completely wet surfaces.

- B. Locate vent holes at the highest point and drainage holes at the lowest point each member.
- C. Interconnect all sections of fabricated pipework with full open tee or with miter joints. Each enclosed section must be provided with a vent hole at each end.
- D. Base plates and end plates must be designed to facilitate venting and draining. Fully cutting the plate provides minimum obstruction to a full, free flow into and out of the pipe. Since this is not always possible, the use of vent holes in the plate often provides a solution.
- E. Close vent holes with drive caps or plugs installed after galvanizing, hammer in and file off flush with surrounding surfaces.
- F. Completely submerge tubular structures in one dip in the galvanizing kettle.
- G. Provide vent and drainage holes in internal gusset plates and end flanges. In circular hollow shapes these should be located diametrically opposite to each other at opposite ends of the member.
- H. In rectangular hollow shapes, the four corners of the internal gusset plates should be cropped. Internal gusset plates in all large hollow sections should be provided with an additional opening at the center.

3.5 FASTENING TO IN-PLACE CONSTRUCTION:

- A. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal items, including ladder, cages, alternating tread ladders, etc. to in-place construction; using threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, wood screws and other connectors as required.

3.6 CUTTING, FITTING AND PLACEMENT:

- A. Perform cutting, drilling and fitting required for installation of miscellaneous metal items. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry, or similar construction.
- B. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

3.7 FIELD WELDING:

- A. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

3.8 ADJUSTING AND CLEANING:

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.9 TOUCH-UP PAINTING:

- A. Cleaning and touch-up painting of field welds, bolted connections and abraded areas of the shop paint on miscellaneous metal is specified in Division 09.

3.10 INSTALLING FLOOR MOUNTED METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
- B. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch (19-mm) bolts at each bollard unless otherwise indicated.
- C. Anchor bollards in place with concrete footings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- D. Fill non-capped bollards solidly with concrete, mounding top surface to shed water.
- E. Provide 1/8" nominal wall thickness polyethylene thermoplastic (HDPE) covers where indicated.

3.11 INSTALLING METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
- B. Where bollards are indicated to extend below floor and/or pavement/grade, provide 24 inch diameter, 4,000 psi concrete pier from grade to 8 inches minimum below bottom of the bollard. Shore and brace bollard in position until concrete has cured. Place concrete and vibrate or tamp for consolidation. Slope top of concrete pier 1/4 per foot.
- C. Fill non-capped bollards solidly with concrete, mounding top surface to shed water.
- D. Provide 1/8" nominal wall thickness polyethylene thermoplastic (HDPE) covers where indicated.

3.12 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
- C. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.13 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 50 00

SECTION 05 52 00 - HANDRAILS AND RAILINGS

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. All metal handrails and railings work indicated on the drawings and herein specified.
- B. Exterior Stainless Steel Railings.

1.3 RELATED WORK UNDER OTHER SECTIONS:

- A. Steel supporting framework - other sections of Division 5.

1.4 SUBMITTALS

- A. Manufacturer's Data: For information only, submit copies of manufacturer's specifications, dimension diagrams, anchor details and installation instructions for products to be used in the fabrication of handrails and railings, including prime paint products. Transmit copy of instructions to the Installer.
- B. Shop Drawings: Submit shop drawings for the fabrication and erection of handrail and railing assemblies which are not completely shown by the manufacturer's data sheets. Include plans and elevations at not less than 1" to 1'-0" scale, and include details of sections and connections at not less than 3" to 1'-0" scale. Show anchorage and accessory items.

1.5 MISCELLANEOUS REQUIREMENTS

- A. Qualification for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".
- B. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. However, do not delay job progress; allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the work.
- C. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry for the installation of the handrails and railings work.
- D. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.

1. See concrete and masonry sections of these specifications for installation of inserts and anchorage devices.
- E. Shop Assembly: Preassemble items in the shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Metal Surfaces, General: For the fabrication of handrails and railings which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.
1. Steel Plates, Shapes and Bars: ASTM A 36.
 2. Steel Tubing: ASTM A 501, hot-formed, welded or seamless.
 3. Cold-Finished Steel Bars: ASTM A 108, grade as selected by fabricator.
 4. Steel Pipe: ASTM A 53, Type E or Type S, Grade A; black finish unless galvanizing is indicated; standard weight (Schedule 40); unless otherwise shown or specified.
 5. Malleable Iron Castings: ASTM A 47, grade coordinated selected.
 6. Metal Primer Select primer paint which is compatible with the required finish coats of paint. Coordinate selection of metal primer with finish paint requirements specified in Division 9 of these specifications.
 7. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel, complying with Military Specifications MIL-P-21035 (Ships).
 - a. Products conforming to above specification: ZRC cold galvanizing compound.
 8. Where galvanizing prior to completing fabrication cannot be avoided, joints shall be welded after fabrication, ground smooth and finished with four (4) full coats of California Products Corp. WW Totrust, Sealube ZRC, ZIRP by Duncan Galvanizing or approved equal.

2.2 FABRICATION:

- A. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32", unless otherwise shown. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.
- B. Weld corners and seams continuously and in accordance with the recommendations of AWS. Grind exposed welds smooth and flush, to match and blend with adjoining surfaces.
- C. Form exposed connections with flush, smooth, hairline joints, using concealed fasteners wherever possible. Use exposed fasteners of the type shown, or if not shown, use Phillips flat-head (countersunk) screws or bolts.
- D. Provide for anchorage of the type shown, coordinated with the supporting structure. Fabricate and space anchoring devices as shown and as required to provide adequate support.

- E. Galvanizing: Provide a zinc coating, with the addition of 0.05 - 0.09% nickel to the zinc bath, for those items shown or specified to be galvanized, using the hot-dip process after fabrication.
1. Comply with ASTM A 153 for galvanizing of iron and steel hardware.
 2. Comply with ASTM A 123 for galvanizing of rolled, pressed and forged steel shapes, plates, bars and strips 1/8" thick and heavier.
- F. After pickling and prior to galvanizing, the steel shall be immersed in a bath of zinc ammonium chloride. The dry kettle process shall be used to eliminate any flux inclusions on the surface of the galvanized material.
- G. Shop Painting:
1. Shop paint all steel handrails and railings, except those members or portions of members, to be embedded in concrete or masonry, surfaces and edges to be field welded, and galvanized surfaces, unless otherwise specified.
 2. Remove scale, rust and other deleterious materials before the shop coat of paint is applied. Clean off heavy rust and loose mill scale in accordance with SSPC SP-2 "Hand Tool Cleaning", or SSPC SP-3 "Power Tool Cleaning" or SSPC SP-7 "Brush-Off Blast Cleaning". Remove oil, grease and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning".
 3. Apply one shop coat of metal primer paint to fabricated metal items, except apply two coats of paint to surfaces which are inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.
 4. Immediately after surface preparation, brush or spray on steel primer paint, applied in accordance with the manufacturer's instructions and at a rate to provide a uniform dry film thickness of 2.0 mils. Use painting methods which will result in full coverage of joints, corners, edges and all exposed surfaces.
- H. Pipe Railings: Custom fabricate pipe railings to the dimensions and details shown, with smooth bends and welded joints ground smooth and flush. Where details are not shown, use 1-1/2" OD steel pipe with top of top rail 42" above the floor (unless shown otherwise) or 34" above stair treads, measured vertically at the stair riser line.
- I. Toe Boards: Provide toe boards, at railings around openings. Fabricate to the dimensions and details shown, or, if not shown, use 6" high x 1/8" steel bar welded to each post of railing and centered under railing posts. Omit toe bar wherever curb or other construction under railing provides the required safety.
- J. Brackets and Anchors: Provide for railing posts and for handrail supports. Furnish inserts and sleeves as required for anchorage to concrete or masonry work.
- K. Wire Mesh for Handrails: Provide wire mesh infill at indicated stairs and handrails, as manufactured by The G-S Company of Baltimore, MD (1-410-284-9549).
1. Mesh to be 2" square, 6 gauge, stair panel inserts, complete with channel edge framing, sized to suit installation, as detailed.
- L. Stainless Steel Railings (when indicated on drawings):
1. Handrails (where indicated on drawings): Pipe railing type.
 - a. Size and configuration as indicated on drawings.
 - b. Material: Type 304 stainless steel pipe, 1-1/2 inch Schedule 10, 1.9 inches (48 mm) outside diameter.

- c. Joints: Coped and fully welded with welds ground smooth.
- d. Top Rail to Post Connection at Open Ends: 4 or 6 inch (100 or 150 mm) radius elbow connection.
- e. Post Mounting: Minimum 6 inches (150 mm) embedded into concrete.
- f. Wall Mounting: Extruded aluminum wall bracket; size to provide minimum of 1-1/2 inches (38 mm) clear space between top rail and wall.
- g. Rail Ends at Wall: Anchored in wall clip allowing thermal movement.
- h. Stainless Steel Finish: Satin, No.4.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Anchorages: Furnish setting drawings, diagrams, templates, instructions and directions for the installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the project site.
- B. Fastening to In-Place Construction:
 - 1. Provide anchorage devices and fasteners necessary to securing handrails and railings to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, and other connectors as required.
- C. Cutting, Fitting and Placement:
 - 1. Perform all cutting, drilling and fitting required for installation. Set the work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
 - 2. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch-up paint coat. Do not weld, cut or abrade the surfaces of units which have been hot-dip galvanized after fabrication, and are intended for bolted field connections.
 - 3. Adjust railings prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 8' on centers, unless otherwise shown. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
 - a. Anchor posts in concrete by means of pipe sleeves set and anchored into the concrete. Provide sleeves of galvanized, standard weight, steel pipe, not less than 6" long, and having an inside diameter not less than 1/2" greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve and of width and length not less than 1" greater than the outside diameter of the sleeve. After the posts have been inserted into the sleeves, fill the annular space flush-type and sleeve solid with molten lead or sulfur or a quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.
 - 4. Products offered by manufacturers to comply with the requirements for hydraulic cement include the following:

- a. Embeco; Master Builder's
 - b. Ferrolith G; Sonneborn Bldg. Products, Inc.
 - c. Por-Rok; Halemite Mfg. Company
5. Anchor posts to steel with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.
 6. Anchor rail ends into concrete and masonry with steel round flanges (unless shown otherwise) welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.
 7. Anchor rail ends to steel with steel oval or round flanges welded to rail ends and bolted to the structural steel members.
 - a. Secure handrails to walls as shown, or by means of wall brackets, and wall return fitting at handrail ends. Provide brackets with not less than 3" projection from the finish wall surface to the center of the pipe handrail, and with the wall plate portion of the bracket drilled to receive one 3/8" bolt. Locate brackets not more than 60" o/c. Provide flush-type wall return fittings with the same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to building construction as follows:
 - 1) For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.
 - 2) For hollow masonry and stud partition anchorage, use toggle bolts having square heads.
 8. Galvanize exterior steel railings, including pipe, fittings, brackets, fasteners and other ferrous metal components. Provide black steel pipe for interior railings. Do not galvanize stainless steel railings.

3.2 GALVANIZING:

- A. Completely clean interior as well as exterior surfaces and coat with zinc. Provide vent holes for air and frothy fluxes to be allowed to flow upward and completely out; cleaning solutions and molten zinc must be allowed to flow in and completely wet the surfaces.
- B. Locate vent holes at the highest point and drainage holes at the lowest point each member.
- C. Interconnect all sections of fabricated pipework with full open tee or with miter joints. Each enclosed section must be provided with a vent hole at each end.
- D. Base plates and end plates must be designed to facilitate venting and draining. Fully cutting the plate provides minimum obstruction to a full, free flow into and out of the pipe. Since this is not always possible, the use of vent holes in the plate often provides a solution.
- E. Close vent holes with drive caps or plugs installed after galvanizing, hammer in and file off flush with surrounding surfaces.
- F. Completely submerge tubular structures in one dip in the galvanizing kettle.
- G. Provide vent and drainage holes in internal gusset plates and end flanges. In circular hollow shapes, locate holes diametrically opposite to each other at opposite ends of the member.
- H. In rectangular hollow shapes, crop the four corners of the internal gusset plates. Internal gusset plates in all large hollow sections should be provided with an additional opening at the center.

3.3 FIELD WELDING:

- A. Comply with AWS Code for the procedures of manual shielded metalarc welding, the appearance and quality of welds made, and the methods used in correcting welding work.

3.4 TOUCH-UP PAINTING:

- A. Refer to Division 9 for cleaning and touch-up painting of field welds, bolted connections and abraded areas of the shop paint on handrails and railings (required immediately after erection and before proceeding with field painting).

END OF SECTION 05 52 00

SECTION 06 10 00 - ROUGH CARPENTRY

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. Materials and installation requirements for other work, commonly assigned to carpentry trade, are specified in other sections of these specifications.
- B. The types of carpentry work specified in this section include (but are not necessarily limited to) the following:
 - 1. Wood furring.
 - 2. Wood grounds, nailers, blocking.
 - 3. Miscellaneous wood framing.
 - 4.
- C. Fire-retardant treated plywood and lumber.

1.3 RELATED WORK UNDER OTHER SECTIONS

- 1. Division 05 Section "Cold Form Metal Framing" for wall blocking.
- 2. Division 06 Section Rough Carpentry and Miscellaneous Rough Carpentry for plywood backing panels.
- 3. Division 06 Section "Sheathing"
- 4. Division 07 Section "Thermal Insulation"
- 5. Division 07 Sections for "Weather Barriers" and 'Air Barriers' for water-resistive barrier applied over wall sheathing.
- 6. Division 09 Sections for Gypsum Board products.
- 7. Division 26, 27, and 28 Sections for Electrical, Communications, and/or Security wall mounted equipment.

1.4 SUBMITTALS

- A. Wood Treatment Data: For information only, submit chemical treatment manufacturer's instructions for proper use of each type of treated material.
 - 1. Certificate: Pressure Treatment, for each type specified, include certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.
 - 2. For water-borne preservatives, include statement that moisture content of treated materials was reduced to a maximum of 15% prior to shipment to project site.

- B. Certificates: Fire-Retardant Treatment, certification by testing plant that treatment material complies with this specification and with all governing regulations, and treatment will not bleed through finished surfaces.
- C. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated wood.
 - 2. Fire-retardant-treated wood.
 - 3. Engineered wood and LVL products.
 - 4. Shear panels.
 - 5. Power-driven fasteners.
 - 6. Powder-actuated fasteners.
 - 7. Expansion anchors.
 - 8. Metal framing anchors.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

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. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 4. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that 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.
 - 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.
- 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.

2.3 FIRE-RETARDANT TREATED WOOD:

- A. Fire-Retardant Treatment: AWPA C20 for lumber and AWPA C27 for plywood; noncorrosive type. Provide at building interior where required by code.
- B. Where lumber or plywood is indicated to be fire-retardant treated, provide Dricon Fire-Retardant Treatment Chemicals (NO SUBSTITUTION), to achieve a flame spread rating of not more than 25 when tested in accordance with UL Test 723 or ASTM E 84.
 - 1. Where transparent or paint finish is shown or scheduled for "FR-T" wood, use a fire-retardant treatment which will not bleed through or adversely affect bond of finish.
- C. Complete fabrication prior to treatment, wherever possible, to minimize cutting and jointing after treatment.
- D. Coat surfaces cut after treatment with a heavy brush coat of the same fire-retardant chemical.
- E. Kiln-dry lumber to a maximum moisture content of 19% and plywood to a minimum moisture content of 15%, after treatment.
- F. Inspect each piece of lumber and plywood after drying; do not use warped, twisted, bowed or otherwise damaged or defective pieces.
 - 1. Provide UL label on each piece of fire-retardant treated lumber and plywood.

2.4 LAMINATED-VENEER LUMBER (LVL):

- A. Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559.
- B. Basis of Design: 2.0E GP LAM laminated veneer lumber as manufactured by Georgia-Pacific Wood Products or approved equal.

2.5 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Provide wood for support or attachment of other work such as cant strips, bucks, nailers, blocking, furring, grounds, stripping and similar members. Provide lumber of sizes shown or specified, worked to shapes shown, and as follows:
 - a. Moisture Content: 15% maximum for lumber items not specified to receive wood preservative treatment.
 2. Grade: Construction Grade light framing size lumber of any species, or board size lumber, as required. Provide Construction Grade boards (RIS or WCLIB) or No. 2 boards (SPIB or WWPA).
- B. For items of dimension lumber size, provide Construction, or No. 2 grade lumber and any of the following species with moisture content not exceeding 15%:
1. Hem-fir (north); NLGA.
 2. Mixed 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.
 8. Eastern softwoods; NeLMA.
- C. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
1. Mixed southern pine; No. 2 grade; SPIB.
 2. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
 3. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
 4. Eastern softwoods; No. 2 Common grade; NeLMA.
 5. Northern species; No. 2 Common grade; NLGA.
 6. Western woods; Construction or No. 2 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.
- G. Plywood Exposed to Exterior:
1. Smooth Surface: A-C/EXT-APA with "A" face exposed or MDO/EXT-APA.
- H. Plywood Exposed on Interior:
1. Smooth Surface: A-D/INT-APA with "A" face exposed or MDO/EXT-APA.
- I. Concealed Plywood: [Provide fire retardant treated plywood where required by building &/or fire codes for project construction type that require concealed wood to be fire retardant treated].

1. Exterior: C-D/INT-APA with exterior glue or C-C/EXT-APA.
 2. Interior: C-D Plugged/INT-APA.
- J. Electrical Panel Backboards: For backing panels of electrical and communication equipment, provide 3/4 inch (19 mm) C-D/INT-APA with exterior glue, fire-retardant treated. Paint plywood prior to installation of electrical and/or communication components. Color to be battleship gray.

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 rough 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 A 153/A 153M.
- B. Power-Driven Fasteners: NES NER-272.
- C. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- D. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).
- E. Wood Screws: ASME B18.6.1
- F. Screws for securing wood to metal stud framing: Self tapping: Teks #12 2-3/4 in. Phillips Flat-Head Self-Drilling Screws manufactured by ITW Buildex and Illinois Tool Works, Inc; Phillips II Plus Wood to Metal Screws manufactured by Phillips Fasteners, Fastenal or other similar products specifically recommended for use securing wood to metal stud framing.
- G. Screws specifically designed for securing through metal to wood blocking #10-24x 1-7/16 inch self-drilling flat head as manufactured by Fastenal; ITW Buildex and Illinois Tool Works; Phillips Fasteners, or other manufacturer providing products specifically designed for securing blocking when first drilling through metal to engage the wood blocking.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Install plywood backing panels on stud walls 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. Install plywood backing panels on CMU and/or concrete walls by fastening to pressure treated 2x4 framing installed vertically on the CMU/concrete wall surface; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- E. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- F. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.
- G. 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.
- H. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches (2438 mm) o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal- (38-mm actual-) thickness.
 - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. (9.3 sq. m) and to solidly fill space below partitions.
 - 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet (6 m) o.c.
- I. 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.
- J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 4. Wood Screws: ASME B18.6.1

- K. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesives (for School projects) 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." Revise first paragraph below to include other kinds of nails if required.
- L. 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.
- M. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
1. Comply with approved and/or indicated fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
 2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.
 3. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or 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. Where wood-preserved-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- D. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.
- E. ROOF BLOCKING FASTENERS
1. All blocking shall be fastened in compliance with the guidelines set-forth in the latest Factory Mutual publications.
 2. Fasteners for wood blocking shall be staggered and spaced twelve (12) inches on center. The staggered fastening pattern shall be increased within eight (8) feet from outside corners to six (6) inches on center. Smaller pieces of blocking, such as at penetrations, shall have a minimum of four fasteners per piece. A fastener shall be located no more than four inches from the end of each piece of blocking.
 3. Counter bore at all bolt heads, nuts, and washers as may be required to provide a flush surface for installation of new roofing materials.

3.3 WOOD FURRING INSTALLATION

- A. Install plumb and level with closure strips at edges and openings. Shim with wood as required.
 - 1. Firestop furred spaces on walls at each floor level, with wood blocking or incombustible materials, accurately fitted to close furred spaces. Comply with governing regulations.
- B. Furring to Receive Gypsum Drywall: Unless otherwise shown, provide 1" x 3" furring at 24" o/c. spacing, in the direction required for support of drywall; refer to Division 09.
- C. Suspended Furring: Provide size and spacing shown, including hangers and attachment devices.
- D. Tolerance: Shim and level wood furring to a tolerance of 1/8" in 10'-0", except 1/4" in 10'-0" at thick coat plaster work.

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 rough carpentry from weather. If, despite protection, rough carpentry becomes wet or sufficiently wet that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- C. Where wood preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

END OF SECTION 06 10 00

SECTION 06 16 00 - SHEATHING

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. This Project is seeking LEED certification. The Contractor shall be familiar with and shall adhere to LEED BC+C: V4. Refer to section 01 81 10 SUSTAINABLE DESIGN REQUIREMENTS for additional information and LEED scorecard.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Roof sheathing.
 - 3. Composite nail base insulated roof sheathing.
 - 4. Subflooring.
 - 5. Underlayment.
 - 6. Sheathing joint and penetration treatment.
 - 7. Thermal Wall Sheathing

1.3 RELATED WORK UNDER OTHER SECTIONS

- 1. Division 05 Section "Cold Form Metal Framing"
- 2. Division 06 Section Rough Carpentry and Miscellaneous Rough Carpentry for plywood backing panels.
- 3. Division 07 Section "Thermal Insulation"
- 4. Division 07 Sections for "Weather Barriers" and 'Air Barriers' for water-resistive barrier applied over wall sheathing.

1.4 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 plywood complies 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 plywood complies with requirements. Include physical properties of treated materials.
 - 3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
 - 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.

5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. LEED Submittals:

1. Certificates for [**Credit MR 6**] [**Credit MR 7**]: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
2. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
3. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that product contains no urea formaldehyde.
4. Laboratory Test Reports for Credit IEQ 4: For adhesives and composite wood products, documentation indicating that products 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."

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For following products, from ICC-ES:

1. Preservative-treated plywood.
2. Fire-retardant-treated plywood.
3. Foam-plastic sheathing.

1.6 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.

1.7 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-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory." or GA-600, "Fire Resistance Design Manual."

2.2 WOOD PANEL PRODUCTS

- A. Emissions: Products shall meet 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. Certified Wood: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
 1. Plywood.
 2. Oriented strand board.
 3. Fiberboard wall sheathing.
 4. Particleboard underlayment.
 5. Hardboard underlayment.
- C. Plywood: Either DOC PS 1 or DOC PS 2 unless otherwise indicated.
- D. Oriented Strand Board: DOC PS 2.
- E. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- F. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated, use materials complying 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 Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, 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 (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. 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 D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) shall be not less than span ratings specified.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat plywood indicated on Drawings, and the following:
1. Roof and wall sheathing within 48 inches (1220 mm) of fire party walls.
 2. Roof sheathing.
 3. Subflooring and underlayment for raised platforms.

2.5 WALL SHEATHING

- A. Plywood Wall Sheathing: Exterior Exposure 1, Structural I sheathing.
1. Span Rating: Not less than 20/0.
 2. Nominal Thickness: Not less than 1/2 inch (13 mm).
- B. Oriented-Strand-Board Wall Sheathing: Exterior Exposure I, Structural I sheathing.
1. Span Rating: Not less than 20/0.
 2. Nominal Thickness: Not less than 1/2 inch (13 mm).
- C. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. G-P Gypsum Corporation; Dens-Glass Gold.
 - b. United States Gypsum Co.; Securock.
 2. Type and Thickness: Regular, 1/2 inch (13 mm) or Type X, 5/8 inch (15.9 mm) thick.
- D. Cellulose Fiber-Reinforced Gypsum Sheathing: ASTM C 1278/C 1278M, gypsum sheathing.
1. Product: Subject to compliance with requirements, provide "Fiberock Sheathing with Aqua-Tough" by United States Gypsum Co.
 2. Type and Thickness: Type X, 5/8 inch (15.9 mm) thick.
- E. Cementitious Backer Units: ASTM C 1325, Type A.

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. C-Cure; C-Cure Board 990.
 - b. Custom Building Products; Wonderboard.
 - c. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
 - d. USG Corporation; DUROCK Cement Board.
 - e. **<Insert manufacturer's name; product name or designation>**.
2. Thickness: 1/2 inch (12.7 mm), 5/8 inch (15.9 mm), or as indicated.

2.6 THERMAL WALL SHEATHING

- A. General: For concealed continuous insulation layer to be applied over a layer of Wall Sheathing to meet the Energy Code for continuous insulation out board of wall framing.
- B. Extruded-Polystyrene-Foam Wall Sheathing for continuous thermal insulation: ASTM C 578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with 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. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning.
 - d. Pactiv, Inc.
 - e. **<Insert manufacturer's name>**.
 2. Thickness: As indicated.
- C. Foil-Faced, Polyisocyanurate-Foam Wall Sheathing for continuous thermal insulation: ASTM C 1289, Type I or Type II, Class 2, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings shall have a flame-spread index of 25 or less when tested individually.
 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. Atlas Roofing Corporation.
 - b. Dow Chemical Company (The).
 - c. Rmax, Inc.
 - d. **<Insert manufacturer's name>**.
 2. Thickness: As indicated.

2.7 ROOF SHEATHING

- A. Plywood Roof Sheathing: Exterior, Structural sheathing.
 1. Span Rating: Not less than **[16/0] [20/0] [24/0] [32/16] [40/20] [48/24]**.
 2. Nominal Thickness: Not less than **5/8 inch (16 mm)**.
- B. Oriented-Strand-Board Roof Sheathing: **[Exposure 1, Structural I] [Exposure 1]** sheathing.
 1. Span Rating: Not less than **[16/0] [20/0] [24/0] [24/16] [32/16] [40/20] [48/24]**.
 2. Nominal Thickness: Not less than **[5/8 inch (16 mm)]**.

2.8 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

- A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: Rigid, cellular, polyisocyanurate thermal insulation with oriented strand board laminated to one face complying with ASTM C 1289, Type V.
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. Atlas Roofing Corporation.
 - b. Cornell Corporation.
 - c. Dow Chemical Company (The).
 - d. Johns Manville; Berkshire Hathaway Inc.
 - e. Rmax, Inc.
 - f. <Insert manufacturer's name>.
 2. Polyisocyanurate-Foam Thickness: **minimum 2 inches (50 mm)** [2-1/2 inches (64 mm)] [3 inches (76 mm)] [3-1/2 inches (89 mm)] [4 inches (102 mm)] or as indicated.
 3. Oriented-Strand-Board Nominal Thickness: **5/8 inch (15.9 mm) minimum or as indicated.**
- B. Vented, Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: Rigid, cellular, polyisocyanurate thermal insulation complying with ASTM C 1289, Type II, Class 1, with oriented strand board adhered to spacers on one face.
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. Atlas Roofing Corporation.
 - b. Cornell Corporation.
 - c. Dow Chemical Company (The).
 - d. Johns Manville; Berkshire Hathaway Inc.
 - e. Rmax, Inc.
 - f. <Insert manufacturer's name>.
 2. Polyisocyanurate-Foam Thickness [not including the vented recess]: **minimum 2 inches (50 mm)** [2-1/2 inches (64 mm)] [3 inches (76 mm)] [3-1/2 inches (89 mm)] [4 inches (102 mm)] or as indicated.
 3. Oriented-Strand-Board Nominal Thickness: minimum 5/8 inch (15.9 mm) or as indicated.
 4. Spacers: Wood furring strips or blocks not less than 3/4 inch (19 mm) thick and spaced not more than 16 inches (400 mm) o.c.

2.9 SUBFLOORING AND UNDERLAYMENT

- A. General. Provide two separate layers for the subflooring and underlayment. Combination of both the subflooring and underlayment in a single layer is not acceptable for this project.
- B. Plywood Subfloor or Underlayment: DOC PS 1, Exterior, Structural I, C-C Plugged [Exterior, C-C Plugged] [Exposure 1, Structural I, Underlayment] [Exposure 1, Underlayment] single-floor panels.
1. Span Rating: Not less than [16] [20] [24] [32] [48] o.c.
 2. Nominal Thickness: Not less than 23/32 inch (18.3 mm).
 3. Edge Detail: Tongue and groove.

4. Surface Finish: Fully sanded face when required for floor finish indicated.
- C. Oriented-Strand-Board or Subfloor-Underlayment: Exposure 1 single-floor panels.
1. Span Rating: Not less than [16] [20] [24] [32] [48] o.c.
 2. Nominal Thickness: Not less than 23/32 inch (18.3 mm).
 3. Edge Detail: Tongue and groove.
 4. Surface Finish: Fully sanded or Resin-impregnated overlay face as required for floor finish indicated.
- D. Plywood Subflooring: Exterior, Structural single-floor panels or sheathing.
1. Span Rating: Not less than [16] [20] [24] [32] [48] o.c. [or] [32/16] [40/20] [48/24].
 2. Nominal Thickness: Not less than 23/32 inch (18.3 mm).
- E. Oriented-Strand-Board Subflooring: Exposure 1.
1. Span Rating: Not less than [16] [20] [24] [32] [48] o.c. [or] [32/16] [40/20] [48/24] [60/32].
 2. Nominal Thickness: Not less than 23/32 inch (18.3 mm).
- F. Underlayment, General: Provide underlayment in nominal thicknesses indicated or, if not indicated, not less than 3/8 inch (9.5 mm) over smooth subfloors and not less than **1/2 inch (13 mm)** over board or uneven subfloors.
- G. Plywood Underlayment for Resilient Flooring: DOC PS 1, Exterior A-C with fully sanded face.
- H. Plywood Underlayment for Ceramic Tile: DOC PS 1, Exterior, C-C Plugged, not less than 5/8-inch (15.9-mm) nominal thickness, for ceramic tile set in organic adhesive, epoxy adhesive, EGP (exterior glue plywood), or latex-portland cement mortar.
- I. Plywood Underlayment for Carpet: DOC PS 1, Exterior, C-C Plugged or Exposure 1, Underlayment.
- J. Particleboard Underlayment: ANSI A208.1, Grade PBU or Grade M-2, made with binder containing no urea formaldehyde.
- K. Hardboard Underlayment: ANSI A135.4, Class 4 (Service), Surface S1S; with back side sanded.

2.10 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 A 153/A 153M or Type 304 stainless steel finish veneer dependent.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
1. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

- F. 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, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C 1002.
 2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C 954.
- G. Screws for Fastening Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117. Provide washers or plates if recommended by sheathing manufacturer.

2.11 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Division 07 Section "Joint Sealants."

2.12 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 or ASTM D 3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
1. Adhesives shall have a VOC content of 50 to 70g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesives (for School Projects) 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."

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. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
 3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."

- D. Use common wire 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. Install fasteners without splitting wood.
- E. Coordinate wall and/or roof 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.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. 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 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 - 1. Combination Subfloor-Underlayment when indicated and allowed:
 - a. Glue and screw to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch (3 mm) apart at edges and ends.
 - 2. Subflooring:
 - a. Glue and screw to wood framing.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch (3 mm) apart at edges and ends.
 - 3. Wall and Roof Sheathing:
 - a. Nail to wood framing. Apply a continuous bead of glue to framing members at edges of wall sheathing panels.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch (3 mm) apart at edges and ends.
 - 4. Underlayment:
 - a. Screw to subflooring.
 - b. Space panels 1/32 inch (0.8 mm) apart at edges and ends.
 - c. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.

3.3 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to wood framing with screws.
 - 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 3. Install boards with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
 - 4. Install boards with a 1/4-inch (6.4-mm) 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 boards

without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of boards.
2. For sheathing under stucco cladding, boards 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. Seal sheathing joints according to sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.

3.4 CEMENTITIOUS BACKER UNIT INSTALLATION

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.5 FOAM-PLASTIC SHEATHING INSTALLATION

A. Comply with manufacturer's written instructions.

B. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of moisture vapor that otherwise would be trapped in stud cavity behind sheathing.

C. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

3.6 PARTICLEBOARD UNDERLAYMENT INSTALLATION

A. Comply with CPA's recommendations for type of subfloor indicated. Fill and sand gouges, gaps, and chipped edges. Sand uneven joints flush.

1. Fastening Method: Glue and nail underlayment to subflooring.

3.7 HARDBOARD UNDERLAYMENT INSTALLATION

A. Comply with CPA's recommendations and hardboard manufacturer's written instructions for preparing and applying hardboard underlayment.

1. Fastening Method: Nail underlayment to subflooring.

END OF SECTION 06 16 00

SECTION 06 40 00 - ARCHITECTURAL WOODWORK

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. The extent of each type of architectural woodwork is shown. Architectural woodwork is defined to include (in addition to items so designated on the drawings) all exterior and interior miscellaneous exposed to view woodwork and wood members commonly known as "Finish Carpentry" or "Millwork", except where specified under another section of these specifications.
- B. The types of architectural woodwork include, but are not necessarily limited to, the following:
 - 1. Standing and running trim, including wood handrails.
 - 2. Wood casework and countertops with transparent and/or plastic laminate finish.
 - 3. Wood shelving.
 - 4. Custom wood paneling.
 - 5. Plastic trim.
- C. The installation and finishing of architectural woodwork includes, but is not necessarily limited to:
 - 1. Factory finishing of the work in this Section.
 - 2. Shimming, furring and blocking.
 - 3. Installation of the work in this Section.

1.3 RELATED WORK UNDER OTHER SECTIONS:

- A. Division 6 Section – "Rough Carpentry".
- B. Division 06 Section – "Solid Surfacing".
- C. Division 8 Section – "Wood Doors".

1.4 QUALITY ASSURANCE:

- A. Quality Standards: Except as otherwise shown or specified, comply with specified provisions of the following:
 - 1. Architectural Woodwork Institute (AWI) "Quality Standards", current edition.
- B. Quality Marking: Mark each unit of architectural woodwork with mill's or fabricator's identification and grade mark, located on surfaces which will not be exposed after installation.

- C. Work in this section shall be performed by a firm certified by the Architectural Woodwork Institute (AWI) Quality Certification Program.
- D. Work in this section shall comply with the specified grade(s) of work and section(s) of the current edition of the Architectural Woodwork Institute quality standards.
- E. Compliance shall be evidenced by the firm through the application of AWI Quality Certification Program labels on the work according to AWI/QCP labeling guidelines.
- F. Certification Labels shall be applied to each item of work.
 - 1. The Contractor, upon award of the Work, shall register the work under this section with the AWI Quality Certification Program. AWI QCP Phone 1-800-449-8811.

1.5 SUBMITTALS:

- A. Manufacturer's Data: Submit manufacturer's specifications and installation instructions for each item of factory-fabricated woodwork.
 - 1. Quality Certification: Submit manufacturer's (fabricator's) certification, stating that the fabricated work meets the woodwork grade(s) specified.
 - 2. Shop Drawings: Submit shop drawings of the Work in this Section showing location of each item, dimensioned plans and elevations, large scale details, attachment devices and other components as per AWI Appendix.
- B. Samples: Submit the following samples for each species and cut or pattern of architectural woodwork:
 - 1. Wood for transparent finish, set of three pieces, 6" x 3/4" x 2'-0", finished on one side and one edge.
 - 2. Plastic laminate; manufacturer standard chain, minimum twenty (20) colors, not including wood grains or marbles.
 - 3. Exposed cabinet hardware; one unit of each type and finish.
 - 4. Woodwork for transparent finish: Submit range type samples in sets of two or more, illustrating the possible range of the natural characteristics in the species selected for approval. Prefinished samples shall be step-type showing the range from bare wood to the completed finish. Finish steps shall be fully described on the manufacturer label.
 - 5. Flitch samples: Prior to submittal of finished samples, submit full size, full length flitches for each required veneer.
- C. Mock-Ups:
 - 1. Submit mock-ups for each item of Work in this Section.
 - 2. Verify that the Work in this Section may be fabricated and install in complete accordance with the original design, accepted Shop Drawings, and referenced standards.
 - 3. Prior to fabrication or installing the Work in this Section, construct mockups to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups of the full size, using materials indicated for final unit of work.
 - 4. Mock-ups may be incorporated into the Work after approval from Architect and/or governing authorities.
 - 5. Mock-ups shall show reveals, transitions, joinery, and attachments.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Protect woodwork during transit, delivery, storage and handling to prevent damage, soiling and deterioration.
- B. Do not deliver woodwork, until painting, wet work, grinding and similar operations which could damage, soil or deteriorate woodwork have been completed in installation areas. If, due to unforeseen circumstances, woodwork must be stored in other than installation areas, store only in areas meeting requirements specified for installation areas. Comply with AWI Section 1700-G-3.

1.7 JOB CONDITIONS:

- A. Examine the substrates and conditions under which the work is to be installed; and notify the Contractor in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Conditioning: Advise the Contractor of temperature and humidity requirements for woodwork installation areas. Do not install woodwork until the required temperature and relative humidity have been stabilized and will be maintained in installation areas.
- C. Maintain temperature and humidity in installation area as required to maintain moisture content of installed woodwork within a 1.0 percent tolerance of the optimum moisture content, from the date of installation through the remainder of the construction period. The fabricator of the woodwork shall determine the optimum moisture content and required temperature and humidity conditions. Comply with AWI Section 1700-G-4.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS AND FABRICATION METHODS:

- A. General: Except as otherwise indicated, comply with the following requirements for the Work in this Section:
 - 1. All Work in this Section shall be AWI Premium Grade unless otherwise indicated.
- B. Provide materials and workmanship that comply with the requirements of the AWI quality standard for each type of woodwork and quality grade indicated. If the following products are part of the Work in this Section, provide materials that comply with the referenced product standards that apply to the product characteristics indicated.
 - 1. ANSI A208.1 - Wood Particleboard.
 - 2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 3. AWI QSI Current Edition - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute.
 - 4. AWPA C2 - Lumber, Timbers, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes; American Wood Preservers Association.
 - 5. HPVA HP-1 - Voluntary Standard for Hardwood and Decorative Plywood; Hardwood Plywood and Veneer Association.
 - 6. NIST PS 1 - Construction and Industrial Plywood.
 - 7. NIST PS 20 - American Softwood Lumber Standard.

8. Curved Hardwood Plywood: HPVA HP-1 Grade AA Type II Core Type J; Graded in accordance with AWI Premium; 3/4 inch (19 mm) thick, 7 ply veneer core, consisting of 3 hardwood plies with grain perpendicular to each other and 1/16 inch (1.6 mm) thick crossbands; form continuous curved panel under controlled pressure methods, type of glue recommended for application; Grade AA veneer. Run grain of face and back veneers vertically. Contact cemented or saw-kerfed and bent plywood will NOT be accepted.
 9. Fire Retardant Particleboard: ANSI A208.1 Type 1, Fire Retardant, UL Class 1.
- C. Wood Moisture Content: Comply with requirements of referenced quality standard for the moisture content of the Work in this Section in relation to relative humidity conditions existing during the time of fabrication and in installation areas; 5% to 10% for interior work and 9% to 15% for exterior work (AWI 100-S-11).
- D. Fire Treated Materials and Locations:
1. Fire resistance requirements: Treat those items required to be treated by authorities having jurisdiction over Work, and those items indicated as "Fire Retardant Treated Wood".

2.2 INTERIOR MATERIALS:

- A. Wood for Transparent Finish: Provide the species and grade or cut as follows, unless otherwise indicated:
1. Solid Wood: Red oak plain cut or as indicated on drawings.
 2. Hardwood Plywood: Red oak plain cut or as indicated on drawings, 3/4" thick, balanced construction.
- B. Wood for Painted Finish: Closed grain hardwood, any species.
- C. Plastic Laminate: Comply with NEMA LD1; type, thickness, color, pattern and finish as indicated for each application.
- D. Miscellaneous Concealed Materials: Unless specified herein, provide concealed materials, as part of the work of this section, conforming to the following requirements:
1. Softwood: Fir or Pine; 1" nominal thickness unless otherwise shown.
 2. Plywood: Fir, DFPA B-B, or better; 3/4" thick, unless shown otherwise.
 3. Particleboard: Unless specified otherwise, provide mat-formed, Type 1-B-2 of CS 236; filled ; 3/4" thick unless shown otherwise.
 4. Hardboard: Tempered; perforated where so indicated; smooth surface(s) where not concealed; 1/8" minimum thickness except as otherwise specified or shown.
 5. Wheat Board: "Supreme Wheat" manufactured by PrimeBoard, or approved equal; high performance, formaldehyde emissions free particleboard that meets the requirements of ANSI A208.1-1999 for the grade requested. Independently tested and mill certified to meet or exceed all published M-3 Industrial grade ANSI A208.1-1999 specifications with reference to ASTM D 1037-96a. Conforming to the following:
 - a. Density: 43 lb/ft³ (689 kg/m³)
 - b. Modulus of Rupture: 3,700 psi (25.5 N/mm)
 - c. Modulus of Elasticity: 500,000 psi (3,447 N/mm)
- E. Standing and Running Trim: AWI Section 300, Premium grade, transparent finish.

1. If indicated to be painted, provide closed grain hardwood.
 - a. Fabricate wood trim to dimensions, profiles and details shown. Rout or groove reverse side (backed-out) of trim members to be applied to flat surfaces, except for members with ends exposed in the finished work. Shop fabricate to the greatest extent possible.
- F. Shelving for Transparent Finish: (where exposed to view, in public areas, adjacent casework items, coat and hat shelves, and where indicated as "hardwood"):
 1. Hardwood plywood, as previously specified.
- G. Shelving for Paint Finish: (Concealed; in closets and storage rooms)
 1. Quality and Grade: AWI Section 600, Premium Grade.
 2. Material: Wood, plywood, or particleboard capable of supporting 30 pounds per square foot with a 1/4 inch maximum deflection; with metal or wood pole to support 10 pounds per lineal foot with a maximum deflection of 1/4 inch.
 3. Edges: Edgeband all exposed edges on fixed shelves and all edges of adjustable shelving unless indicated otherwise.
 4. Provide shelf and bracket hardware, coat rod and hooks, where indicated or required.
- H. Casework, General Requirements:
 1. Casework Portions: Refer to the definitions in the specified quality standards for the following:
 - a. Exposed Portions: Provide materials as shown and as further specified.
 - b. Semi-Exposed Portions: Provide materials as shown and as further specified.
 - c. Concealed Portions: Provide sound materials of any wood species.
 2. Casework Doors: Comply with the thickness and door size limitations of the specified quality standards.
 - a. Doors larger than 30" wide or 80" high shall be 1-3/8" minimum thickness.
 3. Case Hardware Inclusions: (unless shown otherwise)
 - a. Finish: US 26D.
 - b. Standards and Supports: KV 255 and 256.
 - c. Drawer Slides: KV 1300 (two per drawer).
 - d. Catches: Epcos #590, provide two for doors over 3'-0" high.
 - e. Hinges: Stanley 1535 or 1590 where required, provide three for doors over 3'-0" high.
 - f. Pulls: Stanley 4484.
 - g. Locks: (where required) KV #985.
 - h. Sliding Tracks: (where indicated) Epcos #234 and 2234.
 - i. Clothes Pole: (where required) KV 770 with 734 and 735 brackets.
 4. Casework for Transparent Finish: AWI Section 400, Premium grade.
 5. Specialty Hardware for indicated locations: Hafele, as specified.
 - a. At Kitchen and Break Rooms - Hafele "Stainless Steel and Zinc Handles" #104.74.063
 - b. At Conference Rooms Built-Ins - Hafele "Modern Zinc Handles" #104.64.402

6. Specialty hardware for Built-In Work Surfaces and Reception Desks: Doug Mockett & Co., as specified.
 - a. Wire Managers: G-Shape, WM-4 Series, with accessories.
 - b. Clean Line Wire Managers: CL Series, with all accessories.
 - c. Grommets: Innovator #INNV2, 4-9/16", Two Slot, color as selected.
7. Plastic Bullnose Trim: PVC, Super High Gloss, furniture grade, full projection, as distributed by Outwater Plastics Industries.

2.3 PLASTIC LAMINATE WORK:

- A. General: Where counters are indicated or required, provide complete with plastic laminated faces, edges, backsplashes and side splashes. Provide balancing (backing) sheets where required by AWI 400-26.
- B. Material Surface Quality:
 1. Horizontal Surfaces: Grade 10 (0.048" thick), general-purpose type, (high pressure).
 2. Horizontal Surfaces: Grade 41 (0.051" thick), solid core type, high pressure.
 3. Exposed Surfaces: Grade 20 (0.020" thick), general-purpose type (high-pressure).
 4. Semi-Exposed parts: High-Pressure Laminate compatible color, nominal .028" thick.
 5. Concealed parts: Grades 72 or 91, as required, (0.020" thick), backer type, (high-pressure).
 6. Manufacture: Formica, grades as indicated; Wilson Art, or Nevamar; of the colors, textures, finish (reflectance) and patterns as selected.
- C. Core: 3/4" thick particleboard, CS 236, Type 2, medium density, Class 1; Norbord "MR" Medium Density Fiberboard, Wheat Board; or other AWI approved core materials.
- D. Quality for Integral Work: Where plastic laminate finished elements are an integral part of wood casework, provide same Quality Grade specified for other portions of casework.
- E. Core for casework and countertops where sinks occur: Shop sanded exterior grade veneer core plywood; or industrial grade phenolic resin particleboard, fiberboard or wheat board with a 24 hr. thickness swell factor of 5% or less and a 24 hr. water absorption factor of 10% or less.
- F. Openings: Cut openings in tops for equipment which is to be installed under other sections of these specifications. Verify size of opening with actual size of equipment to be used, prior to making openings. Form inside corners to a radius of not less than 1/8". After sawing, rout and file cutouts to ensure smooth, crack-free edges. Seal exposed edges after cutting with a waterproofing material recommended by the top material manufacturer.

2.4 CELLULAR PVC PLASTIC FABRICATION TRIM

- A. Where indicated for exterior trim.
- B. Bases of Design: AZEK Trim boards as manufactured by Vycom Corporation or approved equal.
- C. Accessory Products: Provide manufacturer's recommended and/or required stainless steel fasteners, manufacturer's supplied adhesives and sealants (manufacturer's approved type: urethane, polyurethane or acrylic based sealants without silicone).

- D. Provide manufacturer's standard 25 year warranty against defects in manufacturing that causes the product to rot, corrode, delaminate, or swell from moisture.
- E. Material must be free of voids, holes, cracks, foreign inclusions and other defects. Edges must square with top to bottom surfaces that shall be flat with no convex or concave deviations. The uniform surface shall be free from cupping, warping and twisting.

2.5 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
 - 1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or 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 UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
 - 1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
 - 2. Interior Type A: Low-hygroscopic formulation.
 - 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
 - 4. Mill lumber before treatment and implement special 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 treated woodwork.
 - 5. Kiln-dry materials before and after treatment to levels required for untreated materials.
- C. Fire-Retardant Particleboard: Panels complying with the following requirements, 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 per ASTM E 84.
 - 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. Product: Subject to compliance with requirements, provide "Duraf Flake FR" by Weyerhaeuser.
- D. Fire-Retardant Fiberboard: Medium-density fiberboard 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 per ASTM E 84.

1. Product: Subject to compliance with requirements, provide "Medite FR" by SierraPine Ltd.; Medite Div.

2.6 PANELING AND RELATED ITEMS:

- A. AWI Section 500 Premium Grade.
- B. Wood Specie: Plain Sliced Red Oak or as indicated on drawings.
 1. Matching between adjacent veneer leaves: Book matching and architectural end match.
 2. Matching within individual panel faces: Balance and center match.
 3. Method of matching panels: Blueprint matched panels and components.
- C. Flush panels less than 3' X 6' shall be 3-ply balanced construction. Larger panels shall be 5-ply balanced construction.
- D. Shop prepare and identify sheets for grain matching during site erection. Prepare panels for delivery to site, permitting passage through building openings.
- E. Shop prepare joinery to the greatest extent possible. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

2.7 FINISH FOR ARCHITECTURAL WOODWORK:

- A. General: The entire finish of architectural woodwork is work of this section, regardless of whether shop applied or applied after installation.
- B. Comply with AWI Quality Standards, Section 1500 Premium Grade, for sanding, filling countersunk fasteners, back priming and similar preparations for the finishing of architectural woodwork, as applicable to each unit of work. Sand Work smooth and set exposed nails and screws. Apply wood filler in exposed nail and screw indentations. Use wood filler that matches surrounding surfaces.
 1. AWI Transparent Finish System: TR-4 Water White Conversion Varnish.
 2. Sheen on 60° Gloss Meter (ASTM D 523): 40 Satin 30°-50°.
 3. Effect: Open Pore.
 4. Stain: Match Architects Sample.
- C. Back prime and seal concealed or internal surfaces with two coats sealer compatible with thickness of exposed finish.

PART 3 - EXECUTION

3.1 PREPARATION:

- A. Condition woodwork to average prevailing humidity conditions in installation areas prior to installing.

- B. Do not deliver Work in this Section until all wet work is completed and that building is permanently enclosed and that the HVAC is operational.
- C. Pre-Installation Meeting: Meet at the project site prior to delivery of architectural woodwork and review the coordination and environmental controls required for proper installation and ambient conditioning in the areas to receive the work. Include in the meeting the Contractor, and the related sub-contractors, the Architect and other Owner representatives (if any). Proceed with the woodwork installation only when everyone concerned agrees that the required ambient conditions can be properly maintained.
- D. Deliver concrete inserts and similar anchoring devices to be built into substrates, well in advance of the time substrates are to be built.
- E. Prior to installation of architectural woodwork, examine shop-fabricated work for completion and complete work as required, including back priming and removal of packing. Verify adequacy of backing and internal support framing.

3.2 INSTALLATION:

- A. Comply with AWI Section 1700 Premium Grade.
- B. Install the work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8" in 8'-0" for plumb and level (including countertops); and with 1/16" maximum offset in flush adjoining surfaces, 1/8" maximum offsets in revealed adjoining surfaces.
- C. Scribe and cut work to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.
- D. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns, miter at corners, and comply with Quality Standards for joinery.
- E. Anchor woodwork, including wood handrails, to anchors or blocking built-in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fasteners heads are required, use fine finishing nail for exposed nailings, countersunk and filled flush with woodwork, and matching finish where transparent finish is indicated.
 - 1. Countersink anchorage devices, at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with adjacent surface.
- F. Casework: Install without distortion so that doors and drawers will fit openings properly and be accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated. Maintain veneer sequence matching (if any) of casework with transparent finish.
- G. Countertops: Anchor securely to base units and other support systems as indicated.
 - 1. Where tops and/or splashes do not abut the adjacent wall surfaces, provide a clear paintable caulking bead or other approved trim closure.

- H. Wood Shelving: Complete the assembly of units and install in the areas indicated, including hardware and accessories as indicated.
- I. Install Paneling to supporting substrate with concealed metal Panelclip© as manufactured by Brooklyn Hardware, 4770 SE Milwaukee, Portland, OR 97202, 888-232-1151, and follow manufacturer's recommendations for their installation. The maximum length of Panelclip on the backs of the panels: 2-1/2".

3.3 FASTENING OF INTERIOR WOODWORK:

- A. Nailing: Blind nail where possible; where not possible, use fine finishing nails, countersunk, then fill voids with color-matched putty stick.
- B. Anchoring: Secure woodwork to anchors or blocking built-in or directly attached to substrates.

3.4 CELLULAR PVC PLASTIC FABRICATIONS

- A. Store material on flat level surface on a full shipping pallet. Handle materials to prevent damage to product edges and corners. Edges must be square, and top and bottom surfaces shall be flat with no convex or concave deviation.
- B. Installation: Comply with manufacturer's written installation instructions and product technical bulletins instructions for this construction project design requirements.
- C. Fasteners: Install with wood trim fasteners (thinner shank, blunt point, full round head) that extend minimum of 1 1/2" into solid wood substrate. Use two fasteners per every framing member for trim board applications. Install fasteners maximum of 2" from end of each board. Do not use staples, small brads or wire nails.
- D. Adhesives: Prepare all surfaces to be bonded per manufacture's recommendations. Glue all trim joints with manufacturer's adhesive to prevent joint separation. Glue joint to be secured with fastener and/or fastened on each side of the joint to allow adequate bonding time.
- E. Sealants: Use urethane, polyurethane or acrylic based sealants without silicone and as recommended by manufacturer's written instructions.
- F. Painting: Prepare surface as recommended by manufacturer and fill all nail holes with polyurethane or acrylic based caulk. Provide one coat using 100% acrylic latex paint with light Reflective Value of (LRV) of 55 or higher. Follow paint manufacturer's recommendations for applying painting system.

3.5 ADJUSTMENT, CLEANING, FINISHING AND PROTECTION:

- A. Repair damaged and defective woodwork wherever possible to eliminate defects functionally and visually; where not possible to repair properly, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean hardware, lubricate and make final adjustments for proper operation.
- C. Clean woodwork on exposed and semi-exposed surfaces, including spaces within casework cabinets. Touch-up shop-applied finishes to restore damaged or soiled areas.

- D. Complete the finishing work specified as work of this section, to whatever extent not completed at the shop or prior to installation of woodwork.
- E. Protection: Advise the Contractor of final protection and conditions to be maintained to ensure that the work will be without damage or deterioration at the time of acceptance.

END OF SECTION 06 40 00

SECTION 071320 - SHEET MEMBRANE WATERPROOFING

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. Modified bituminous sheet waterproofing.
2. Modified bituminous sheet waterproofing, fabric reinforced.
3. Modified bituminous deck-paving sheet waterproofing.
4. Bonded HDPE or polyethylene sheet waterproofing.

B. Related Requirements:

1. Division 07 Section "Expansion Control" for plaza- or foundation-wall expansion-joint assemblies that interface with waterproofing.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [**Project site**] <**Insert location**>.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.4 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. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material

manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

- C. 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.
 - 1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.
- D. Samples: For each exposed product and for each color and texture specified, including the following products:
 - 1. **8-by-8-inch (200-by-200-mm)** square of waterproofing and flashing sheet.
 - 2. **8-by-8-inch (200-by-200-mm)** square of insulation.
 - 3. **4-by-4-inch (100-by-100-mm)** square of drainage panel.
 - 4. Plaza-deck paver, [**4-by-4-inch (100-by-100-mm) square**] [**full sized**], in each color and texture required.
 - 5. Paver pedestal assembly.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.
 - 1. Build for each typical waterproofing installation including[**pavers and**] accessories to demonstrate surface preparation, crack and joint treatment, corner treatment, and protection.
 - a. Size: [**100 sq. ft. (9.3 sq. m) in area**] [**As shown on Drawings**].
 - b. Description: Each type of [wall] [deck] [and] [plaza] <Insert description> installation.
 - 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 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.

1.8 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: [**Three**] [**Five**] <Insert number> years from date of Substantial Completion.
- B. Installer's Special Warranty: Specified form, [**on warranty form at end of this Section**], signed by Installer, covering Work of this Section, for warranty period of [**two**] <Insert number> years.
 1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials[, **protection course**,] [**and**] [**molded-sheet drainage panels**] from single source from single manufacturer.
- B. Source Limitations for Plaza-Deck Paving: Obtain plaza-deck pavers[**and paver pedestals**] from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Modified Bituminous Sheet: Minimum **60-mil (1.5-mm)** nominal thickness, self-adhering sheet consisting of **56 mils (1.4 mm)** of rubberized asphalt laminated on one side to a **4-mil- (0.10-mm-)** thick, polyethylene-film reinforcement, and with release liner on adhesive

side[; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction].

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. American Hydrotech, Inc.; VM75.
 - b. Carlisle Coatings & Waterproofing Inc.; CCW MiraDRI 860/861.
 - c. CETCO Building Materials Group, a subsidiary of AMCOL International Corp.; Envirosheet.
 - d. Grace, W. R., & Co. - Conn.; [Bituthene 3000/Low Temperature] [or] [Bituthene 4000].
 - e. Henry Company; Blueskin WP 100/200.
 - f. Meadows, W. R., Inc.; SealTight Mel-Rol.
 - g. Nervastral, Inc.; BITU-MEM.
 - h. Polyguard Products, Inc.; Polyguard 650.
 - i. Protecto Wrap Company; PW 100/60.
 - j. Tamko Building Products, Inc.; TW-60.
 - k. York Manufacturing, Inc.; HydroGard.
 - l. <Insert manufacturer's name; product name or designation>.
 2. Physical Properties:
 - a. Tensile Strength, Membrane: 250 psi (1.7 MPa) 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 (minus 29 deg C); ASTM D 1970.
 - d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C 836.
 - e. Puncture Resistance: 40 lbf (180 N) minimum; ASTM E 154.
 - f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D 570.
 - g. Water Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m) maximum; ASTM E 96/E 96M, Water Method.
 - h. Hydrostatic-Head Resistance: [200 feet (60 m)] <Insert value> minimum; ASTM D 5385.
 3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.
- B. Modified Bituminous Sheet, Fabric Reinforced: Minimum 60-mil (1.5-mm) nominal thickness, self-adhering sheet consisting of rubberized-asphalt membrane with embedded fabric reinforcement, and with release liner on adhesive side.
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

- a. Protecto Wrap Company; Jiffy Seal 140/60.
 - b. Royston, Div. of Chase Specialty Coatings; [104AHT Membrane] [Royal-Gard Plus Membrane 104ARHT].
 - c. <Insert manufacturer's name; product name or designation>.
2. Physical Properties:
- a. Pliability: No cracks when bent 180 degrees over a 1-inch (25-mm) mandrel at minus 25 deg F (minus 32 deg C); ASTM D 146.
 - b. Puncture Resistance: [40 lbf (180 N)] [100 lbf (445 N)] minimum; ASTM E 154.
 - c. Water Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m) maximum; ASTM E 96/E 96M, Water Method.
3. Sheet Strips: Self-adhering, reinforced, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.3 MODIFIED BITUMINOUS DECK-PAVING SHEET WATERPROOFING

- A. Modified Bituminous Deck-Paving Sheet: Minimum 65-mil (1.6-mm) nominal thickness, self-adhering sheets designed to be overlaid with asphalt paving; consisting of rubberized-asphalt membrane with woven or nonwoven fabric reinforcement laminated to one surface or embedded within the membrane, and with release liner on adhesive side.

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Carlisle Coatings & Waterproofing Inc.; [Pre-Pave CCW 711W] [or] [Pre-Pave CCW 711NW].
 - b. Meadows, W. R., Inc.; SealTight Mel-Dek.
 - c. Polyguard Products, Inc.; [Polyguard 665] [or] [Polyguard NW-75].
 - d. Protecto Wrap Company; Jiffy Seal 400.
 - e. Royston, Div. of Chase Specialty Coatings; [Bridge Waterproofing Membrane 10A] [Bridge Waterproofing Membrane 10A Easy Pave] [Bridge Waterproofing Membrane 10A-65] [Bridge and Railroad Bridge Membrane 10A 90 MIL].
 - f. <Insert manufacturer's name; product name or designation>.
2. Physical Properties:
 - a. Tensile Strength, Membrane: [50 lbf/in. (8.75 kN/m)] <Insert value> minimum; ASTM D 882.
 - b. Pliability: Unaffected when bent 180 degrees over a 1/4-inch (6.4-mm) mandrel at minus 15 deg F (minus 26 deg C); ASTM D 146.
 - c. Puncture Resistance, Mesh: [40 lbf (180 N)] [100 lbf (445 N)] [200 lbf (890 N)] minimum; ASTM E 154.
3. Sheet Strips: Self-adhering, reinforced, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.4 BONDED HDPE OR POLYETHYLENE SHEET WATERPROOFING

A. Products: Subject to compliance with requirements, **[provide the following]** **[provide one of the following]** **[available products that may be incorporated into the Work include, but are not limited to, the following]:**

1. Vertical Applications:

- a. Grace, W. R., & Co. - Conn.; Preprufe 160R[**with Preprufe Tie-Back Covers**].
- b. Polyguard Products, Inc.; Underseal Blindsid Membrane.
- c. **<Insert manufacturer's name; product name or designation>**.

2. Horizontal Applications:

- a. Grace, W. R., & Co. - Conn.; Preprufe 300R.
- b. Polyguard Products, Inc.; Underseal Underslab Membrane.
- c. **<Insert manufacturer's name; product name or designation>**.

B. Bonded HDPE Sheet for Vertical Applications: Uniform, flexible, multilayered-composite sheet membrane consisting of either a HDPE film coated with a pressure-sensitive adhesive and protective release liner, total **32-mil (0.8-mm)** thickness, or an HDPE film coated with a modified asphalt layer and a nonwoven geotextile-fabric final layer, total **73-mil (1.9-mm)** thickness; with the following physical properties:

1. Tensile Strength, Film: **4000 psi (27.6 MPa)** minimum; ASTM D 412.
2. Low-Temperature Flexibility: Pass at **minus 10 deg F (minus 23 deg C)**; ASTM D 1970.
3. Peel Adhesion to Concrete: **5 lbf/in. (875 N/m)** minimum; ASTM D 903, modified.
4. Lap Adhesion: **2.5 lbf/in. (440 N/m)** minimum; ASTM D 1876, modified.
5. Hydrostatic-Head Resistance: **231 feet (70 m)**; ASTM D 5385, modified.
6. Puncture Resistance: **100 lbf (445 N)** minimum; ASTM E 154.
7. Water Vapor Permeance: **0.01 perms (0.6 ng/Pa x s x sq. m)** maximum; ASTM E 96/E 96M, Water Method.
8. Water Absorption: 0.5 percent maximum; ASTM D 570.

C. Bonded HDPE or Polyethylene Sheet for Horizontal Applications: Uniform, flexible, multilayered-composite sheet membrane consisting of either an HDPE film coated with pressure-sensitive adhesive and protective release liner, total **46-mil (1.2-mm)** thickness, or a cross-laminated film of low- and medium-density polyethylene, coated with a modified asphalt layer and a nonwoven geotextile-fabric final layer, total **95-mil (2.4-mm)** thickness; with the following physical properties:

1. Tensile Strength, Film: **2000 psi (13.8 MPa)** minimum; ASTM D 412.
2. Low-Temperature Flexibility: Pass at **minus 10 deg F (minus 23 deg C)**; ASTM D 1970.
3. Peel Adhesion to Concrete: **5 lbf/in. (875 N/m)** minimum; ASTM D 903, modified.
4. Lap Adhesion: **2.5 lbf/in. (440 N/m)** minimum; ASTM D 1876, modified.
5. Hydrostatic-Head Resistance: **231 feet (70 m)**; ASTM D 5385, modified.
6. Puncture Resistance: **200 lbf (890 N)** minimum; ASTM E 154.
7. Water Vapor Permeance: **0.01 perms (0.6 ng/Pa x s x sq. m)** maximum; ASTM E 96/E 96M, Water Method.
8. Water Absorption: 0.5 percent maximum; ASTM D 570.

- D. Mastic, Adhesives, and Detail Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.

2.5 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 [**waterborne**] [**solvent-borne**] primer recommended for substrate by sheet-waterproofing material manufacturer.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet-waterproofing material manufacturer.
- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.
- E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.
- F. Metal Termination Bars: Aluminum bars, approximately **1 by 1/8 inch (25 by 3 mm)** thick, predrilled at **9-inch (229-mm)** centers.
- G. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
 - 1. Thickness: [**1/8 inch (3 mm)**] [**1/4 inch (6 mm)**], nominal.
 - 2. Thickness: **1/8 inch (3 mm)**, nominal, for vertical applications; **1/4 inch (6 mm)**, nominal, elsewhere.
 - 3. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for protection course type.
- H. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced on [**one side**] [**or**] [**both sides**] with plastic film, nominal thickness **1/4 inch (6 mm)**, with compressive strength of not less than **8 psi (55 kPa)** per ASTM D 1621, and maximum water absorption by volume of 0.6 percent per ASTM C 272.
- I. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, **1/2 inch (13 mm)** thick.
- J. Protection Course: Molded-polystyrene board insulation, ASTM C 578, Type I, **0.90-lb/cu. ft. (15-kg/cu. m)** minimum density, **1-inch (25-mm)** minimum thickness.

2.6 MOLDED-SHEET DRAINAGE PANELS

- A. Molded-Sheet Drainage Panel: Comply with Division 33 Section "Subdrainage."

- B. 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 (0.21-mm)** 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 15 gpm per ft. (112 to 188 L/min. per m)**.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. American Hydrotech, Inc.; **[Hydrodrain 400] [or] [Hydrodrain 420]**.
 - b. Carlisle Coatings & Waterproofing Inc.; **[CCW MiraDRAIN 6000] [CCW MiraDRAIN 6000XL] [CCW MiraDRAIN 6200] [or] [CCW MiraDRAIN 6200XL]**.
 - c. Grace, W. R., & Co. - Conn.; **[Hydroduct 220] [or] [Hydroduct 660]**.
 - d. Protecto Wrap Company; Protecto Drain 2000-V.
 - e. **<Insert manufacturer's name; product name or designation>**.
- C. Woven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panels consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding **No. 40 (0.425-mm)** sieve laminated to one side of the core[**and a polymeric film bonded to the other side**]; and with a horizontal flow rate not less than **2.8 gpm per ft. (35 L/min. per m)**.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. American Hydrotech, Inc.; Hydrodrain 700.
 - b. Carlisle Coatings & Waterproofing Inc.; **[CCW MiraDRAIN 9000] [or] [CCW MiraDRAIN 9900]**.
 - c. Grace, W. R., & Co. - Conn.; Hydroduct 225.
 - d. Protecto Wrap Company; Protecto Drain 2000-H.
 - e. **<Insert manufacturer's name; product name or designation>**.
- D. High-Capacity, Molded-Sheet Collector-Panel System: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding **No. 40 (0.425-mm)** 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 15 gpm per ft. (112 to 188 L/min. per m)** and a horizontal flow rate **[as indicated on Drawings] <Insert requirement>**. Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with piped subdrainage system specified in Division 33 Section "Subdrainage."
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Carlisle Coatings & Waterproofing Inc.; CCW QuickDRAIN.

- b. Grace, W. R., & Co. - Conn.; Hydroduct Coil 600.
- c. <Insert manufacturer's name; product name or designation>.

2.7 INSULATION

- A. Insulation, General: Comply with Division 07 Section "Thermal Insulation."
- B. Board Insulation: Extruded-polystyrene board insulation complying with ASTM C 578, [square] [or] [shiplap] edged.
 - 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. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning Insulating Systems LLC.
 - d. Pactiv Building Products.
 - e. T. Clear Corporation, a subsidiary of Fin Pan Inc.
 - f. <Insert manufacturer's name>.
 - 2. Type IV, 25-psi (173-kPa) minimum compressive strength.
 - 3. Type VI, 40-psi (276-kPa) minimum compressive strength.
 - 4. Type VII, 60-psi (414-kPa) minimum compressive strength.
 - 5. Type V, 100-psi (690-kPa) minimum compressive strength.

2.8 INSULATION DRAINAGE PANELS

- A. Unfaced Wall-Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, [Type IV, 25-psi (173-kPa)] [or] [Type VI, 40-psi (276-kPa)] minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
 - 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. DiversiFoam Products; [CertiFoam 25 SL] [or] [CertiFoam 40 (with channel edges)] Drainage Board.
 - b. Dow Chemical Company (The); Styrofoam Perimate.
 - c. <Insert manufacturer's name; product name or designation>.
- B. Geotextile-Faced, Wall-Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, [Type IV, 25-psi (173-kPa)] [or] [Type VI, 40-psi (276-kPa)] minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.

1. Products: Subject to compliance with requirements, **[provide the following]** **[provide one of the following]** **[available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Owens Corning Insulating Systems LLC; Insul-Drain.
 - b. T. Clear Corporation, a subsidiary of Fin Pan Inc.; **[Thermadry 750]** **[or]** **[Thermadry 1250]**.
 - c. **<Insert manufacturer's name; product name or designation>**.

- C. Unfaced Plaza-Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, **[Type VI, 40-psi (276-kPa)]** **[or]** **[Type VII, 60-psi (414-kPa)]** minimum compressive strength; unfaced; fabricated with shiplapped, channel, or tongue-and-groove edges and with one side having ribbed drainage channels.
 1. Products: Subject to compliance with requirements, **[provide the following]** **[provide one of the following]** **[available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. American Hydrotech, Inc.; Hydroguard.
 - b. DiversiFoam Products; CertiFoam Plaza Deck.
 - c. Dow Chemical Company (The); Styrofoam Ribbed Roofmate.
 - d. Owens Corning Insulating Systems LLC; **[Foamular 404 RB]** **[Foamular 604 RB]**.
 - e. **<Insert manufacturer's name; product name or designation>**.

- D. Geotextile-Faced, Plaza-Deck Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, **[Type VI, 40-psi (276-kPa)]** **[or]** **[Type VII, 60-psi (414-kPa)]** minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with manufacturer's standard, nonwoven geotextile filter fabric.
 1. Products: Subject to compliance with requirements, **[provide the following]** **[provide one of the following]** **[available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. T. Clear Corporation, a subsidiary of Fin Pan Inc.; **[Thermadry 1250]** **[or]** **[Thermadry 1750]**.
 - b. **<Insert manufacturer's name; product name or designation>**.

2.9 PLAZA-DECK PAVERS

- A. Plaza-Deck Pavers: **[Brick]** **[Concrete]** **[Asphalt-block]** pavers specified in Division 32 Section "Unit Paving."
- B. Stone Plaza-Deck Pavers: **[Granite]** **[Limestone]** **[Marble]** **[Quartz-based stone]** **[Slate]** **[Travertine]** **[Rough-stone]** pavers specified in Division **[09 Section "Stone Flooring]** **[32 Section "Unit Paving]."**

- C. Concrete Plaza-Deck Pavers: Solid, hydraulically pressed, standard-weight concrete units, [square edged] [with top edges beveled 3/16 inch (5 mm)], manufactured for use as plaza-deck pavers; [7500-psi (52-MPa)] [6500-psi (45-MPa)] <Insert value> minimum compressive strength, ASTM C 140; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
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] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 - a. Hanover Architectural Products.
 - b. Roofblok Limited.
 - c. Sunny Brook Pressed Concrete Co.
 - d. Wausau Tile, Inc.
 - e. Westile Roofing Products.
 - f. <Insert manufacturer's name>.
 3. Regional Materials: Concrete plaza-deck pavers shall be manufactured within 500 miles (800 km) of Project site from aggregates[and cement] that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
 4. Thickness: [1-5/8 inches (41 mm)] [1-3/4 inches (45 mm)] [2 inches (51 mm)] [2-3/8 inches (60 mm)] <Insert dimension>.
 5. Face Size: [8-7/8 inches (225 mm) square] [9 inches (229 mm) square] [9 by 18 inches (229 by 457 mm)] [12 inches (305 mm) square] [12 by 24 inches (305 by 610 mm)] [18 inches (457 mm) square] [24 inches (610 mm) square] [As indicated] <Insert dimension(s) and shape>.
 6. Color: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.
- D. Setting Bed: Provide [aggregate] [mortar] [bituminous] setting-bed materials specified in Division 32 Section "Unit Paving."
- E. Paver Pedestals: Paver manufacturer's standard paver support assembly, including [fixed-height] [adjustable or stackable] pedestals, shims, and spacer tabs for joint spacing of [1/8 inch (3 mm)] [3/16 inch (5 mm)] [1/8 to 3/16 inch (3 to 5 mm)].
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. <Insert, in separate subparagraphs, manufacturer's name; product name or designation>.
 2. Concrete Fill: ACI 301, compressive strength of 5000 psi (34 MPa) at 28 days, and air content of 6 percent.

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 according to ASTM D 4263.
 - 3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrates according to 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 according to ASTM D 4258.
 - 1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of **[1/16 inch (1.6 mm)] [or] [1/8 inch (3 mm) for modified bituminous deck-paving waterproofing]**.
- F. Bridge and cover **[isolation joints] [expansion joints] [and]** discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths according to manufacturer's written instructions.
 - 1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.

1. Install membrane strips centered over vertical inside corners. Install **3/4-inch (19-mm)** 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.
 - b. At plaza-deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.
- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

3.3 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

- A. Install modified bituminous sheets according to 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. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform **2-1/2-inch- (64-mm-)** 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 (minus 4 and plus 5 deg C)**, 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 (16 deg C)**.
- D. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths, to provide a minimum of two thicknesses of sheet membrane over areas to receive waterproofing.
- E. Horizontal Application: Apply sheets from low to high points of decks to ensure that laps shed water.
- F. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- G. Seal edges of sheet-waterproofing terminations with mastic.
- H. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.
- I. 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 (150 mm)** beyond repaired areas in all directions.
- J. Immediately install protection course with butted joints over waterproofing membrane.

1. **[Molded-sheet drainage panels] [Insulation drainage panels] [Board insulation]** may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

3.4 MODIFIED BITUMINOUS DECK-PAVING SHEET-WATERPROOFING APPLICATION

- A. Install modified bituminous deck-paving sheets according to waterproofing manufacturer's written instructions.
- 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. Apply and firmly adhere sheets over areas to receive waterproofing. Accurately align sheets and maintain uniform **2-1/2-inch- (64-mm-)** minimum side-lap widths and **6-inch (150-mm)** end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
- D. Apply sheet waterproofing from low to high points of decks to ensure that laps shed water.
- E. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- F. Seal edges of sheet-waterproofing terminations with mastic.
- G. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.
- H. Repair tears, voids, and lapped seams in waterproofing that do not comply with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending **6 inches (150 mm)** beyond repaired areas in all directions.

3.5 BONDED HDPE OR POLYETHYLENE SHEET-WATERPROOFING APPLICATION

- A. Install bonded HDPE or polyethylene sheets according to 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 HDPE 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 HDPE or polyethylene 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.
- H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Tape perimeter of damaged or nonconforming area extending **6 inches (150 mm)** beyond repaired areas in all directions. Apply a patch of sheet waterproofing and firmly secure with detail tape.

3.6 MOLDED-SHEET DRAINAGE-PANEL INSTALLATION

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to 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 **[board insulation] [protection course]** before installing drainage panels.

3.7 INSULATION INSTALLATION

- A. Install one or more layers of board insulation to achieve required thickness over waterproofed surfaces. Cut and fit to within **3/4 inch (19 mm)** of projections and penetrations.
- B. On vertical surfaces, set insulation units in adhesive or tape applied according to manufacturer's written instructions.
- C. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.8 INSULATION DRAINAGE-PANEL INSTALLATION

- A. Install insulation drainage panels over waterproofed surfaces; cut and fit to within **3/4 inch (19 mm)** of projections and penetrations.
- B. Ensure that drainage channels are aligned and free of obstructions.
- C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied according to manufacturer's written instructions.
- D. On horizontal surfaces, loosely lay insulation drainage panels according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.9 PLAZA-DECK PAVER INSTALLATION

- A. Install concrete pavers in locations indicated according to manufacturer's written instructions.
- B. Setting Bed: Install setting bed in locations and of thickness indicated. Comply with requirements in Division [09 Section "Stone Flooring] [32 Section "Unit Paving]."
- C. Accurately install paver pedestals and accessories in locations and to elevations required. Adjust for final level and slope.
 - 1. Fill paver pedestal with concrete mix, strike smooth with top of pedestal, and cure according to ACI 301.
- D. Loosely lay pavers on pedestals, maintaining a uniform open joint width. Tightly seat pavers against spacers to eliminate lateral movement or drift of paving assembly. Align joint patterns parallel in each direction.
 - 1. Lay out pavers to avoid less-than-half-width pavers at perimeter or other terminations.
- E. Install pavers to not vary more than 1/16 inch (1.6 mm) in elevation between adjacent pavers or more than 1/16 inch (1.6 mm) from surface plane elevation of individual paver.
- F. Maintain tolerances of paving installation within [1/4 inch in 10 feet (1:48)] <Insert value> of surface plane in any direction.

3.10 FIELD QUALITY CONTROL

- A. [Owner will engage] [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. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
 - 1. Flood to an average depth of 2-1/2 inches (64 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (51 mm) of clearance from top of sheet flashings.
 - 2. Flood each area for [24] [48] [72] hours.
 - 3. After flood testing, repair leaks, repeat flood tests, and make further repairs until waterproofing installation is watertight.
- C. [Owner will engage] [Engage] an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.
- D. Prepare test and inspection reports.

3.11 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 [**board insulation**] [**and**] [**insulation drainage panels**] 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. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071320

SECTION 07 22 00 – THERMAL INSULATION

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. This Project is seeking LEED certification. The Contractor shall be familiar with and shall adhere to LEED BC+C: V4. Refer to section 01 81 10 SUSTAINABLE DESIGN REQUIREMENTS for additional information and LEED scorecard.

1.2 SUMMARY

- A. Section Includes: The applications of blanket, vapor retarders, rigid board insulation include the following (in the thicknesses and/or R value indicated on the drawings or specified herein.):
 - 1. Glass-fiber blanket insulation.
 - 2. Mineral-wool blanket insulation.
 - 3. Vapor retarders.
 - 4. Concealed extruded polystyrene board:
 - a. On concrete foundation walls, unit masonry walls and within cavities, thickness &/or R-value as shown. Where a specific insulation type has not been indicated on the drawings, provide the concealed extruded polystyrene board in a minimum of 2.15" thickness at an R-12 value
 - 5. Concealed extruded polystyrene board, High R value:
 - a. On concrete foundation walls, unit masonry walls and within cavities, thickness &/or R-value as shown.
 - 6. Concealed drainable extruded polystyrene board:
 - a. Installation under exterior insulation finish, and other finishes where recommended or required by the finish veneer manufacture. Coordinate with water barrier membrane installation required.
 - 7. Concealed mineral wool fiber insulation board, non-combustible, semi-rigid insulation board:
 - a. On concrete foundation walls, unit masonry walls and within cavities, thickness &/or R-value as shown.
 - 8. Foam In-Place Insulation:
 - a. Low expanding foam, at perimeter of rigid board insulation; window and door installation; and elsewhere as indicated.
 - 9. Thermal Wall Sheathing Board Insulation.
 - a. On exterior wall sheathing concealed by exterior wall finish veneer, thickness &/or R-value as indicated.

1.3 RELATED WORK UNDER OTHER SECTIONS:

- A. Division 03 Section for Concrete foundations.
- B. Division 04 Section "Unit Masonry".
- C. Division 05 Section "Cold Form Metal Framing"

- D. Division 06 Section "Sheathing".
- E. Division 07 Section "Water-Drainage Exterior Insulation and Finish System (EIFS)."
- F. Division 07 Section "Thermal Insulation, Spray Applied"
- G. Division 07 Section Roofing System for Roof Insulation secured to Roof Deck.
- H. Division 07 Section "Shingles".
- I. Division 07 Section "Sound Attenuation Blankets".
- J. Division 09 Section "Non-Structural Metal Framing".
- K. Division 22 and 23 Sections on Pipe and Duct Insulation.

1.4 QUALITY ASSURANCE:

- A. Thermal Conductivity: The thicknesses shown are for the thermal conductivity (k-value at 75 degrees F) specified for each material. Provide adjusted thicknesses for the equivalent use of material having a different thermal conductivity.
- B. 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.
- C. Fire and Insurance Ratings: Comply with fire-resistance and flammability ratings as shown and specified; and comply with code interpretations by governing authorities.

1.5 SUBMITTALS:

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type of insulation required. Include data substantiating that materials comply with specified requirements.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

1.6 PRODUCT HANDLING:

- A. Protection from Deterioration: Do not allow insulation materials to become wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage, and protection during installation.
 - 1. Protect plastic insulation from exposure to sunlight.
- B. Fire Hazard: Do not deliver plastic insulation materials to the project site ahead of installation time. Protect at all times against ignition. Quickly complete installation and concealment of plastic materials in each area of work, including the installation of fire stopping in cavities.

1.7 JOB CONDITIONS:

- A. Examine the substrate and the conditions under which the work is to be performed, and do not proceed with the insulation work until unsatisfactory conditions have been corrected.

PART 2 - PRODUCTS

2.1 GLASS-FIBER 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. Guardian Building Products, Inc.
 - 3. Johns Manville.
 - 4. Knauf Insulation.
 - 5. Owens Corning.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **<Insert number>** percent.
- C. 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.
- D. Polypropylene-Scrim-Kraft-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II (non-reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).
- E. Reinforced-Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.
- F. Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.
- G. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.
- H. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
 - 1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
 - 2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

2.2 MINERAL-WOOL 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. Fibrex Insulations Inc.
 - 2. Owens Corning.

3. Roxul Inc.
 4. Thermafiber.
- B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <Insert number> percent.
- C. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
- D. Reinforced-Foil-Faced, Mineral-Wool Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less per ASTM E 84); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.
- 2.3 ABOVE CEILING INSULATION: Polyencapsulated formaldehyde-free fiberglass insulation above ceiling where indicate.
- 2.4 VAPOR RETARDERS
- A. Polyethylene Vapor Retarders: ASTM D 4397, **10 mils (0.25 mm)** thick, with maximum permeance rating of 0.10 perm (7.5 ng/Pa x s x sq. m).
- B. Reinforced-Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than 25 lb/1000 sq. ft. (12 kg/100 sq. m), with maximum permeance rating of 0.0507 perm (2.9 ng/Pa x s x sq. m).
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. Raven Industries Inc.; DURA-SKRIM 6WW.
 - b. Reef Industries, Inc.; Griffolyn T-65.
- C. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or polyester scrim and weighing not less than 22 lb/1000 sq. ft. (10 kg/100 sq. m), with maximum permeance rating of 0.1317 perm (7.56 ng/Pa x s x sq. m) and with flame-spread and smoke-developed indexes of not more than 5 and 60, respectively, per ASTM E 84.
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. Raven Industries Inc.; DURA-SKRIM 10FR.
 - b. Reef Industries, Inc.; Griffolyn T-65 FR.
- D. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- E. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.
- F. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.
- G. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

2.5 BOARD INSULATION:

- A. Extruded Polystyrene Plastic Board Insulation: (R-5 minimum per inch)
1. Rigid, closed-cell, expanded polystyrene insulation board with integral high-density skin; complying with ASTM C 578; with 40 psi minimum compressive strength; 1.5 perm-inch maximum vapor transmission; integrally formed skin; 0.7% maximum water absorption; thermal conductivity (k-value at 75 degrees F) of 0.20; manufacturer's standard lengths and widths as required for coordination with wall ties and cavity dimensions.
 - a. DiversiFoam Products.
 - b. Dow Chemical Company.
 - c. Owens Corning.
 - d.
- B. Extruded Polystyrene High R-value Plastic Board Insulation: (R-6 minimum per inch)
1. Rigid, closed-cell, expanded polystyrene insulation board with integral high-density skin; complying with ASTM C 578; with 25 psi minimum compressive strength; 1.5 perm-inch maximum vapor transmission; integrally formed skin; 0.1% maximum water absorption; thermal conductivity (k-value at 75 degrees F) of 0.18; manufacturer's standard lengths and widths as required for coordination with wall ties and cavity dimensions.
 - a. Equal to Foamular High-R CW Plus as manufactured by Owens Corning.
- C. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi (173-kPa) or Type VI, 40-psi (276-kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
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. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Pactiv Building Products.
- D. Mineral Wool Board Insulation:
1. Mineral; complying with ASTM C 578; with 25 psi minimum compressive strength; 0.6 perm-inch maximum vapor transmission; integrally formed skin; 0.1% maximum water absorption; thermal conductivity (k-value at 75 degrees F) of 0.18; manufacturer's standard lengths and widths as required for coordination with wall ties and cavity dimensions.
 - a. Equal to Cavity Rock DD as manufactured by Roxul Inc. (R= 4.2 minimum per inch)

2.6 FOAM-IN-PLACE INSULATION

- A. Manufacturer: Dow Chemical "Great Stuff Pro Window and Door" foam sealant; Powerform as manufactured by Power Fasteners or Touch & Seal Foam Kit Fire Retardant, as manufactured by Convenience Products Division of Clayton Corporation, or products conforming to the following:
1. Installed foam fill shall not distort the insulation and/or frame more than one-sixteenth (0.0625) inch along any side.
 2. Expands only enough to generate an effective seal.
 3. Conforming to American Architectural Manufacturers Association (AAMA) guidelines.
 4. Conforming to American Society for Testing and Materials ASTM E-06/ASTM E 2112 - - Standard Practice for Installation of Exterior Windows, Doors & Skylights.
 5. ASTM 84 flame spread less than 25; smoke development less than 450.

2.7 INSULATION ADHESIVE AND JOINT SEALER

- A. Adhesive: Type recommended by insulation board manufacturer for application indicated.
- B. Seal all insulation gaps, penetrations, joints, gouges, defects as noted 1/8" and less gaps use LT-100 liquid tape as manufactured by York. 3/16" or greater gaps, gouges or defects use low-expansion polyurethane foam insulation.

2.8 THERMAL WALL SHEATHING

- A. General: For continuous insulation layer to be applied over a layer of Wall Sheathing to meet the Energy Code for continuous insulation out board of wall framing.
- B. Extruded-Polystyrene-Foam Wall Sheathing for continuous thermal insulation: ASTM C 578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with 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. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning.
 - d. Pactiv, Inc.
 - e. <Insert manufacturer's name>.
 - 2. Thickness: As indicated.
- C. Foil-Faced, Polyisocyanurate-Foam Wall Sheathing for continuous thermal insulation: ASTM C 1289, Type I or Type II, Class 2, rigid, cellular, polyisocyanurate thermal insulation. Foam-plastic core and facings shall have a flame-spread index of 25 or less when tested individually.
 - 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. Atlas Roofing Corporation.
 - b. Dow Chemical Company (The).
 - c. Rmax, Inc.
 - d. <Insert manufacturer's name>.
 - 2. Thickness: As indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL:

- A. Comply with manufacturer's instructions for the particular conditions of installation in each case. When printed instructions are not available or do not apply to the project conditions, consult the

manufacturer's technical representative for specific recommendations before proceeding with the work.

- 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. 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.
- D. 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 BELOW-GRADE INSULATION

- A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive or loosely laid according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 42 inches below exterior grade line.
- B. On horizontal surfaces when indicated, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

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. Vapor-Retarder: Install retarder to minimize joints and/or damage. Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set retarder as indicated on Drawings, if not indicated on the warm side of the insulated wall.
 - b. Interior Walls: Set retarder as indicated on Drawings, if not indicated, towards the areas of high humidity.
- C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

3.5 INSTALLATION OF VAPOR RETARDERS

- A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.
 - 1. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches (406 mm) o.c.
 - 2. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings.

Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.

3. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.

C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.6 INSTALLATION OF CAVITY-WALL INSULATION

A. At masonry substrate in cavity wall construction, on units of rigid insulation install small pads of mortar or mastic spaced approximately 1'-0" o/c. both ways on inside face, as recommended by manufacturer. Press courses of insulation between wall ties and other confining obstructions in the cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry and other construction, as shown.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 04 Section "Unit Masonry."
2. Seal joints between closed-cell (non-breathing) insulation units by applying mastic or sealant, of the type recommended by the manufacturer, to the edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with mastic or sealant.
3. Use insulation seam/gap sealer on gaps/joints up to 1/4" wide.
4. Use low expansion polyurethane foam for gaps/joints over 1/4" wide and at gouges/depressions, over 1/4", form smooth.

3.7 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.

1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

3.8 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION

A. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install blanket insulation over entire ceiling area in thicknesses indicated. Extend insulation 48 inches (1219 mm) up either side of partitions.

3.9 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, 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 07 22 00

SECTION 07 28 00 – AIR, VAPOR AND WATER BARRIER MEMBRANE

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 specifies a water-resistant fluid-applied air and vapor barrier in exterior wall assemblies. Non-permeable.
- B. Related Work in other Sections include the following:
 - 1. Division 01 Section - Quality Requirements; coordination with Owner's independent testing and inspection agency.
 - 2. Division 01 Section - Mock-Ups; exterior wall mock-ups.
 - 3. Division 01 Section - Temporary Facilities and Controls; requirement to schedule work to prevent sunlight and weather exposure of materials beyond limits established by manufacturer; requirement to protect materials from damage after installation and prior to installation of enclosing work.
 - 4. Division 03 Section – Cast-In-Place Concrete; requirement that backup concrete be free of fins, protrusions and large holes.
 - 5. Division 04 Section – Unit Masonry; requirement that backup masonry joints are flush and completely filled with mortar, and that excess mortar on brick ties will be removed; requirement for gap at deflection joints and fillers; coordination with sequencing of through-wall flashing.
 - 6. Division 07 Section - Spray Polyurethane Foam Air and Vapor Barrier.
 - 7. Division 07 Section - Fluid-Applied Vapor-Permeable Air Barrier.
 - 8. Division 07 Section – Single-ply Membrane Roofing; requirement for coordination with sequencing of membrane roofing; requirement to seal roof membrane to wall air and vapor barrier.
 - 9. Division 07 Section – Joint Sealers
 - 10. Division 07 Section – Sheet Metal Flashing and Trim for Flashing
 - 11. Division 07 Section – Thermal Insulation
 - 12. Division 08 Section – Fenestration Sections for Door & Frames, Storefronts, Windows, Curtainwall, Louvers
 - 13. Division 09 Section – Sheathing; requirement that backup gypsum sheathing has been installed with damaged corners repaired, joints filled and surface flush with compatible material as acceptable to the fluid-applied air and vapor barrier manufacturer; requirement for gap at deflection joints and fillers.

1.3 DEFINITIONS

- A. ABAA: Air Barrier Association of America

- B. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PERFORMANCE REQUIREMENTS

- A. Material Performance: Provide materials which have an air permeance not to exceed 0.004 cubic feet per minute per square foot under a pressure differential of 0.3 in. water (1.57 psf) (0.02 L/m² @ 75 Pa.) when tested according to ASTM E 2178.
- B. Assembly Performance: Provide a continuous air and vapor barrier assembly that has an air leakage not to exceed 0.040 cubic feet per square foot per minute under a pressure differential of 0.3 in. water (1.57 psf) (0.20 L/ m² @ 75 Pa.) when tested in accordance with ASTM E 2357, and a vapor permeance of 1 perm (57 mg) or less when tested in accordance with ASTM E 96 using the desiccant method. Assembly shall perform as a liquid drainage plane flashed to discharge condensation or water penetration to the exterior. Assembly shall accommodate movements of building materials by providing expansion and control joints as required, with accessory air and vapor seal materials at such locations, changes in substrate and perimeter conditions.
 - 1. Assembly shall be capable of withstanding combined positive and negative design wind, fan and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure.
 - 2. Assembly shall not displace adjacent materials under full load.
 - 3. Assembly shall be joined in an airtight and flexible manner to the air barrier material of adjacent assemblies, allowing for the relative movement of assemblies due to thermal and moisture variations and creep, and anticipated seismic movement.
- C. Connections to Adjacent Materials: Provide connections to prevent air leakage and vapor migration at the following locations:
 - 1. Foundation and walls, including penetrations, ties and anchors.
 - 2. Walls, windows, curtain walls, storefronts, louvers or doors.
 - 3. Different wall assemblies, and fixed openings within those assemblies.
 - 4. Wall and roof connections and penetrations.
 - 5. Floors over unconditioned space.
 - 6. Walls, floor and roof across construction, control and expansion joints.
 - 7. Walls, floors and roof to utility, pipe and duct penetrations.
 - 8. Seismic and expansion joints.
 - 9. All other leakage pathways in the building envelope.

1.5 SUBMITTALS

- A. Submittals: Submit in accordance with Division 1 requirements.
- B. Quality Assurance Program: Submit evidence of current accreditation and certification under the Air Barrier Association of America's (ABAA) Quality Assurance Program. Submit accreditation number of manufacturer and certification number of installers.

- C. **Product Data:** Submit manufacturer's product data, installation instructions, and manufacturer's printed instructions for evaluating, preparing, and treating substrate, temperature and other limitations of installation conditions, technical data, and tested physical and performance properties.
 - 1. Submit letter from primary materials manufacturer indicating approval of products not manufactured by primary manufacturer.
 - 2. Include statement that materials are compatible with adjacent materials proposed for use.
 - 3. 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.
 - D. **Samples:** Submit clearly labeled samples, 3 by 4 inch (75 mm by 100 mm) minimum size of each material specified.
 - E. **Shop Drawings of Mock-Up:** Submit shop drawings of proposed mock-ups showing plans, elevations, isometric details, installation sequence, and connections to the test apparatus.
 - F. **Field Test Results of Mock-Up:** Submit test results of air leakage test and water leakage test of mock-up in accordance with specified standards, including retesting if initial results are not satisfactory.
 - G. **Shop Drawings:** Submit shop drawings showing locations and extent of air and vapor barrier assemblies and details of all typical conditions, intersections with other envelope assemblies and materials, membrane counter-flashings, and details showing how gaps in the construction will be bridged, how inside and outside corners are negotiated, how materials that cover the air and vapor barrier are secured with air-tight condition maintained, and how miscellaneous penetrations such as conduits, pipes, electric boxes and similar items are sealed.
 - 1. Include VOC content of each material, and applicable legal limit in the jurisdiction of the project.
 - 2. Include statement that materials are compatible with adjacent materials proposed for use.
 - 3. Include recommended values for field adhesion test on each substrate.
 - H. **Compatibility:** Submit letter from manufacturer stating that materials proposed for use are permanently chemically compatible and adhesively compatible with adjacent materials proposed for use. Submit letter from manufacturer stating that cleaning materials used during installation are chemically compatible with each of the adjacent materials proposed for use.
- 1.6 **QUALITY ASSURANCE**
- A. **Air Barrier Installer Qualifications:** Currently accredited by the Air Barrier Association of America (ABAA) whose applicators are certified in accordance with the ABAA Quality Assurance Program.
 - B. **Manufacturer:** Obtain primary materials from a single manufacturer regularly engaged in manufacturing air and vapor barrier membranes. Obtain secondary materials from a source acceptable to the primary materials manufacturer.

- C. Accredited Laboratory Testing for Materials: Laboratory accredited by International Accreditation Service Inc. (IAS), American Association for Laboratory Accreditation (A2LA), or the Standards Council of Canada (SCC).
- D. VOC Regulations: Provide products which comply with applicable regulations controlling the use of volatile organic compounds for the specific authority having jurisdiction.
- E. Preconstruction Meeting: Convene a minimum of two weeks prior to commencing Work of this Section. Agenda shall include, at a minimum, construction and testing of mock-up, sequence of construction, coordination with substrate preparation, materials approved for use, compatibility of materials, coordination with installation of adjacent and covering materials, and details of construction. Attendance is required by representatives of related trades including covering materials, substrate materials and adjacent materials.
- F. Field Quality Assurance: Implement the ABAA Quality Assurance Program requirements. Cooperate with ABAA inspectors and independent testing and inspection agencies engaged by the Owner. Do not cover air and vapor barrier until it has been inspected, tested and accepted.
- G. Mock-Ups: Build mock-up representative of primary exterior wall assemblies and glazing assemblies including backup wall and typical penetrations as acceptable to the Architect. Mock-up shall be approximately 8 feet long by 8 feet high and include the materials proposed for use in the exterior wall assembly. Mock-up shall be suitable for testing as specified in the following paragraph.
- H. Mock-Up Tests for Air and Water Infiltration: Test mock-up for air and water infiltration in accordance with ASTM E 1186 (air leakage location) or ASTM E 783 (air leakage quantification), and ASTM E 1105 (water penetration). Use smoke tracer to locate sources of air leakage. If deficiencies are found, repair or modify mock-up and retest until satisfactory results are obtained. Deficiencies include air leakage beyond values specified, uncontrolled water leakage, unsatisfactory workmanship.
 - 1. Perform the air leakage tests and water penetration test of mock-up prior to installation of cladding and trim but after installation of all fasteners for cladding and trim and after installation of other penetrating elements. For fasteners which would normally only be installed with cladding, install representative fasteners without cladding; intent is to perform testing with all types of penetrations in place.
- I. Mock-Up Tests for Adhesion: Test mock-up of fluid-applied and sheet applied materials for adhesion in accordance with ASTM D 4541 using a Type 1 pull tester except that the disk used shall be 100mm in diameter and the membrane shall be cut through to separate the material attached to the disk from the surrounding material. Perform test after curing period recommended by the manufacturer. Record mode of failure and area which failed in accordance with ASTM D 4541. When the air barrier material manufacturer has established a minimum adhesion level for the product on the particular substrate, the inspection report shall indicate whether this requirement has been met. Where the manufacturer has not declared a minimum adhesion value for their product/substrate combination, then the inspector shall simply record the value.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product, date of manufacture, and directions for storage.
- B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by air and vapor barrier membrane manufacturer. Protect stored materials from direct sunlight.
- C. Handle materials in accordance with manufacturer's recommendations.

1.8 PROJECT CONDITIONS

- A. Temperature: Install air and vapor barrier within range of ambient and substrate temperatures recommended by air and vapor barrier manufacturer.
- B. Field Conditions: Do not install air and vapor barrier in snow, rain, fog, or mist without temporary protection and supplemental heat as required. Do not install air and vapor barrier when the temperature of substrate surfaces and surrounding air temperatures are below those recommended by the manufacturer. Apply membrane to a surface dry substrate, or in accordance with manufacturer's recommendations.

1.9 WARRANTY

- A. Material Warranty: Provide manufacturer's standard product warranty, for a minimum 3 years from date of Substantial Completion.
- B. Installation Warranty: Provide air barrier subcontractor's 2 year warranty from date of Substantial Completion, including all components of the air and vapor 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

- A. Fluid-Applied Air and Vapor Barrier: Fluid-applied proprietary materials as specified. Use regular or low-temperature formulation depending on site conditions, within temperature ranges specified by manufacturer. Provide related accessories including primer, seam tape, mastic, fluid and sealant recommended by manufacturer. Subject to compliance with requirements, provide one of the following:
 - 1. Carlisle Coatings and Waterproofing:
 - a. Fluid-Applied Air and Vapor Barrier Membrane: Barriseal, 40 mils thick (dry).
 - b. Water-Based Primer: CCW-AWP Water-Based Primer.
 - c. Solvent-Based Primer: CCW-702 Solvent-Based Primer.
 - d. Solvent-Based Aerosol Primer: CAV-GRIP.
 - e. Mastic: CCW-704 Solvent-Based Rubberized Asphalt Mastic.

- f. Sealants: CCW-703 Vertical Grade Liqueal membrane or CCW-201 two component polyurethane sealant.
 - g. Counterflashing for Masonry Through-Wall Flashings: CCW-705.
 - h. Website: www.carlisle-ccw.com.
2. Grace Construction Products:
- a. Fluid-Applied Air and Vapor Barrier: Perm-A-Barrier Liquid, 60 mils thick (wet).
 - b. Water-Based Primer for Flashing, Transition Strip and Detail Membrane: Perm-A-Barrier WB Primer.
 - c. Solvent-Based Primer for Flashing, Transition Strip and Detail Membrane: Bituthene Primer B-2 and Bituthene Primer B2 LVC.
 - d. Through-Wall Flashings or Shelf Angle Flashings: Perm-A-Barrier Wall Flashing.
 - e. Mastics, Adhesives and Tapes: As recommended by Grace Construction Products.
 - f. Transition Strip: Perm-A-Barrier Detail Membrane and Perm-A-Barrier Wall Flashing.
 - g. Termination Mastic: Bituthene Liquid Membrane and as recommended by Grace Construction Products.
 - h. Window Flashing and Detail Membrane: Perm-A-Barrier Detail Membrane and Perm-A-Barrier Wall Flashing.
 - i. Website: www.na.graceconstruction.com.
3. Henry:
- a. Fluid-Applied Air and Vapor Barrier for Cold Temperature Applications: Air Bloc 06, 93 mils (wet).
 - b. Fluid-Applied Air and Vapor Barrier (Also Used as Insulation Adhesive): Air Bloc 21 and AirBloc 21FR fire-resistive type, 120 mils (wet).
 - c. Fluid-Applied Air and Vapor Barrier, Low VOC: Air Bloc 32, 75 to 115 mils thick (wet).
 - d. Transition Membrane: Blueskin SA and Blueskin SA LT for low-temperature applications.
 - e. Water-Based Primer for Transition Membrane: Aquatec Primer.
 - f. Solvent-Based Primer for Transition Membrane: Blueskin Adhesive.
 - g. Solvent-Based Aerosol Primer for Transition Membrane: Blueskin Spray Prep.
 - h. Counterflashing for Masonry Through-Wall Flashing: Blueskin TWF.
 - i. Mastics, Adhesives and Tapes: Henry 570-05 Polybitume.
 - j. Website: www.henry.com.
4. Hohmann & Barnard, Inc:
- a. Fluid-Applied Air and Vapor Barrier Membrane: Textroflash Liquid Air and Vapor Barrier, 60 mils (wet), 40 mils (dry), approximately 25 square feet per gallon.
 - b. Flashing and Transition Membrane: Hohmann and Barnard Textroflash Green, Spun-bonded polypropylene membrane with adhesive and release paper, 40 mils.
 - c. Base Flashing: Hohmann and Barnard Flex-Flash Flashing, 40 mil with pressure sensitive adhesive.
 - d. Primers: As recommended by manufacturer.
 - e. Mastics: As recommended by manufacturer.
 - f. Website: www.h-b.com.

5. Protective Coatings Technology, Inc.:
 - a. Fluid-Applied Air and Vapor Barrier Membrane: Poly-Wall AirLok or AirLok Flex as recommended by manufacturer, 8-12 mils (dry) (50-80 square feet per gallon inversely related to texture and porosity of wall surface).
 - b. Water-Based Primer: As recommended by manufacturer.
 - c. Solvent-Based Primer: Poly-Wall AirLok or AirLok Flex as recommended.
 - d. Counterflashing for Masonry Through-Wall Flashings: Poly-Wall CrackGuard.
 - e. Mastics, Adhesives and Tapes: As recommended by manufacturer.
 - f. Website: www.poly-wall.com.

6. Rubber Polymer Corporation:
 - a. Fluid-Applied Air and Vapor Barrier: Rub-R-Wall Airtight, 40 mils thick (dry) (20 to 25 square feet per gallon).
 - b. Solvent-Based Primer: Rub-R-Wall SA Primer.
 - c. Transition Strip, Counterflashing for Masonry Through-Wall Flashings: Rub-R-Wall SA.
 - d. Mastics: Rub-R-Wall Mastic.
 - e. Website: www.rpcinfo.com.

7. Seaboard Asphalt Products:
 - a. Fluid-Applied Air and Vapor Barrier Membrane: EF-400 Modified Emulsion Coating, 40 mils (dry).
 - b. Flashing and Transition Membrane: Self-adhesive polymeric air and vapor barrier membrane, 40 mils.
 - c. Water-Based Primer for Temperatures Above 40 degrees F: Manufacturer's water-based primer.
 - d. Solvent-Based Primer for Temperatures Above 30 degrees F: Manufacturer's VOC compliant solvent based primer.
 - e. Mastics, Adhesives and Tapes: As recommended by manufacturer.
 - f. Website: www.seaboardasphalt.com.

8. Tremco, Inc.:
 - a. Fluid-Applied Air and Vapor Barrier Membrane: ExoAir 120SP/R (spray-applied and ExoAir 120R (roller-grade), 60 mils (wet) (25 square feet per gallon for sheathing panels and 20 square feet per gallon for unparged masonry walls). ExoAir 220R (roller-grade), 70 mils (wet).
 - b. Water-Based Primer: ExoAir 10 WB Primer.
 - c. Solvent-Based Primer: ExoAir 10 Primer.
 - d. Transition Strips: ExoAir 110/110 LT.
 - e. Counterflashing for Masonry Through-Wall Flashings: ExoAir TWF, Proglaze ETA.
 - f. Mastics, Adhesives and Tapes: ExoAir Termination Mastic.
 - g. Detail Sealants: Tremflex 834 acrylic latex sealant, Dymonic FC polyurethane sealant, or Spectrem 1 silicone sealant.
 - h. Adhesives and Tapes: As recommended by manufacturer.
 - i. Website: www.tremcosealants.com.

9. W. R. Meadows, Inc.:

- a. Fluid-Applied Air and Vapor Barrier: Air-Shield LM and Air-Shield LM All Season (for cold temperature applications), 60 mils (wet), 45 mils (dry).
- b. Detailing Strips: Air-Shield Self-Adhering Air Barrier.
- c. Water-Based Primer: Mel-Prime WB.
- d. Solvent-Based Primer: Mel-Prime VOC and Mel-Prime NE.
- e. Counterflashing for Masonry Through-Wall Flashings: Air-Shield Thru-Wall Flashing.
- f. Mastics, Adhesives and Tapes: Pointing Mastic.
- g. Website: www.wrmeadows.com.

2.2 AUXILIARY MATERIALS

- A. Membrane at Transitions in Substrate and Connections to Adjacent Elements: Neoprene, ASTM D 2000 Designation 2BC415 to 3BC620, 50 to 65 mils (1.3 mm to 1.6 mm) thick with non-corrosive termination bars and fasteners. Adhesive and lap sealant as recommended by manufacturer.
- B. Sealant at Transitions in Substrate and Connections to Adjacent Elements: Low-modulus pre-cured silicone extrusion and sealant for bonding extrusions to substrates; Tremco Silicone Extruded Sheet by Tremco, Proglaze ETA by Tremco, or Bondaflex Silbridge 300 by May National Associates.
- C. Transition Membrane Between Air and Vapor Barrier Membrane and Roofing and Other Adjacent Materials: Comply with both air and vapor barrier manufacturer's recommendations and roofing material manufacturer's recommendations.
- D. Low Expansion Sprayed Polyurethane Foam Sealant: 1 or 2 component, foamed-in-place, polyurethane foam sealant, 1.5 to 2.0 lb/cu. ft (24 to 32 kg/cu. m) density; flame spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions under which air and vapor barrier assemblies will be applied, with Installer present, for compliance with requirements.
 1. Verify that surfaces and conditions are suitable prior to commencing work of this section. Do not proceed with installation until unsatisfactory conditions have been corrected.
 2. Do not proceed with installation until after minimum concrete curing period recommended by air and vapor barrier manufacturer.
 3. Ensure that the following conditions are met:
 - a. Surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants
 - b. Concrete surfaces are cured and dry, smooth without large voids, spalled areas or sharp protrusions.

- c. Masonry joints are flush and completely filled with mortar, and all excess mortar sitting on masonry ties has been removed.
4. Verify substrate is surface dry. Test for capillary moisture by plastic sheet method according to ASTM D 4263 and take suitable measures until substrate passes moisture test. Surface dry is an acceptable substrate condition if acceptable to the manufacturer.
5. Verify sealants used in sheathing are compatible with membrane proposed for use. Perform field peel-adhesion test on materials to which sealants are adhered.
6. Notify Architect in writing of anticipated problems using air and vapor barrier over substrate prior to proceeding.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air and vapor barrier application. Mask off adjoining surfaces to prevent overspray and spillage
- B. Prime substrate for application of sheet membrane transition strips as recommended by manufacturer and as follows:
 1. Prime masonry, concrete substrates with conditioning primer.
 2. Prime glass-fiber surfaced gypsum sheathing an adequate number of coats to achieve required bond, with adequate drying time between coats.
 3. Prime wood, metal, and painted substrates with primer.
 4. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air and vapor barrier and at protrusions.
- C. Prime substrate for application of fluid-applied air and vapor barrier if recommended by manufacturer based on project conditions and as follows.

3.3 INSTALLATION

- A. Air and Vapor Barrier Installation: Install transition strip materials and fluid-applied air and vapor barrier to provide continuity throughout the building envelope. Install materials in accordance with manufacturer's recommendations and as follows, unless manufacturer recommends other procedures in writing based on project conditions or particular requirements of their recommended materials:
 1. Apply primer for transition strips at rate recommended by manufacturer. Allow primer to dry completely before transition strip application. Apply as many coats as necessary for proper adhesion.
 2. Apply primer for fluid-applied air and vapor barrier as recommended by fluid-applied air and vapor barrier manufacturer. Based on manufacturer's recommendation, no primer may be required for the fluid-applied materials.
 3. Apply fluid-applied air and vapor barrier using equipment and methods recommended by manufacturer, to achieve a dry film thickness as recommended by the manufacturer.
 4. Apply fluid-applied air and vapor barrier and transition strips to shed water naturally without interception by a sheet edge, unless that edge is sealed with permanently flexible termination mastic.

5. Position subsequent sheets of transition strips applied above so that membrane overlaps the membrane sheet below by a minimum of 2 inches (50 mm), unless greater overlap is recommended by manufacturer. Roll into place with roller.
6. Overlap horizontally adjacent pieces of transition strips a minimum of 2 inches (50 mm), unless greater overlap is recommended by manufacturer. Roll seams with roller.
7. Seal around all penetrations with termination mastic, extruded silicone sealant, membrane counterflashing or other procedure in accordance with manufacturer's recommendations.
8. Connect air and vapor barrier in exterior wall assembly continuously to the air barrier of the roof, to concrete below-grade structures, to windows, curtain wall, storefront, louvers, exterior doors and other intersection conditions and perform sealing of penetrations, using accessory materials and in accordance with the manufacturer's recommendations.
9. At changes in substrate plane, provide transition material (bead of sealant, mastic, extruded silicone sealant, membrane counterflashing or other material recommended by manufacturer) under membrane to eliminate all sharp 90 degree inside corners and to make a smooth transition from one plane to another.
10. Provide mechanically fastened non-corrosive metal sheet to span gaps in substrate plane and to make a smooth transition from one plane to the other. Membrane shall be continuously supported by substrate or as recommended by the manufacturer.
11. At through-wall flashings, provide an additional 6 inch wide strip of manufacturer's recommended membrane counterflashing to seal top of through-wall flashing to membrane or as recommended by manufacturer. Seal exposed top edge of strip with bead of mastic or as recommended by manufacturer.
12. At deflection and control joints, provide backup for the membrane to accommodate anticipated movement.
13. At expansion and seismic joints provide transition to the joint assemblies.
14. Apply a bead or trowel coat of mastic along membrane seams at reverse lapped seams, rough cuts, and as recommended by the manufacturer.
15. At end of each working day, seal top edge of the self-adhered membrane to substrate with termination mastic.
16. Do not allow materials to come in contact with chemically incompatible materials.
17. Do not expose membrane to sunlight longer than as recommended by the manufacturer.
18. Inspect installation prior to enclosing assembly and repair punctures, damaged areas and inadequately lapped seams with a patch of membrane lapped as recommended by manufacturer.

3.4 FIELD QUALITY CONTROL

- A. Owner's Inspection and Testing/ABAA Audits: Cooperate with Owner's testing agency and ABAA auditors. Allow access to work areas and staging. Notify Owner's testing agency/ABAA auditor 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.

3.5 PROTECTING AND CLEANING

- A. Protect air and vapor barrier assemblies from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Coordinate with installation of materials which cover air and vapor membrane, to ensure exposure period does not exceed that recommended by the air and vapor barrier manufacturer.

- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction and acceptable to the primary material manufacturer.

END OF SECTION 07 28 10

SECTION 074243 - COMPOSITE WALL PANELS

PART I – GENERAL

1.1 SECTION INCLUDES:

- A. Exterior, panelized fiber cement cladding system and accessories to complete a drained and back-ventilated rainscreen.
- B. Interior fiber cement panelized cladding system and accessories.

1.2 RELATED SECTIONS

- A. Section 05 41 00 - Structural Metal Stud Framing
- B. Section 06 10 00 - Rough Carpentry
- C. Section 06 16 00 - Sheathing
- D. Section 07 20 00 - Thermal Protection
- E. Section 07 25 00 - Weather Barriers
- F. Section 07 60 00 - Flashing and Sheet Metal
- G. Section 07 90 00 - Joint Protection

1.3 REFERENCES

- A. American Architectural Manufacturers Association (AAMA):
 - 1. AAMA 509-14 – Voluntary Test and Classification Method of Drained and Back Ventilated Rain Screen Wall Cladding Systems
- B. ASTM International (ASTM):
 - 1. ASTM C 518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 2. ASTM C 1185 - Standard Test Methods for Sampling and Testing Non-Asbestos Fiber Cement.
 - a. ASTM C 1186 – Standard Specification for Flat Fiber-Cement Sheets.
 - 3. ASTM E-84 - Standard Test for Surface Burning Characteristics of Building Materials.
 - 4. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 5. ASTM E 228 - Standard Test Method for Linear Thermal Expansion of Solid Materials with a Vitreous Silica Dilatometer.
 - 6. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

7. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- C. Florida Building Code - Test Protocol HVHZ
 1. Testing Application Standard (TAS) 202, 203 – HVHZ Test Procedures
- D. National Fire Protection Association (NFPA):
 1. NFPA 285 - Fire Test Method for Exterior Wall Assemblies Containing Combustible Material.
 2. NFPA 268 – Ignition Resistance of Exterior Wall Assemblies.
- E. Standards Council of Canada & Underwriters Laboratories Canada (ULC):
 1. CAN/ULC S-102 – Standard Method of Test for Surface Burning Characteristics.
 2. CAN/ULC S-134 – Standard Method of Fire Test of Exterior Wall Assembly.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Submit manufacturer's product description, storage and handling requirements, and installation instructions.
- C. Product Test Reports and Code Compliance: Documents demonstrating product compliance with local building code, such as test reports or Evaluation Reports from qualified, independent testing agencies.
- D. LEED Credits: Provide documentation of LEED Credits for project certification under USGBC LEED 2009 (Version 3.0) or 2012 v.4.
- E. Manufacturer's Details: Submit drawings (.dwg, .rvt, and/or .pdf formats), including plans, sections, showing installation details that demonstrate product dimensions, edge/termination conditions/treatments, compression and control joints, corners, openings, and penetrations.
- F. Samples: Submit samples of each product type proposed for use.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 1. All fiber cement panels specified in this section must be supplied by a manufacturer with a minimum of 10 years of experience in fabricating and supplying fiber cement cladding systems.
 - a. Products covered under this section are to be manufactured in an ISO 9001 certified facility.
 2. Provide technical and design support as needed regarding installation requirements and warranty compliance provisions.
- B. Installer Qualifications: All products listed in this section are to be installed by a single installer trained by manufacturer or representative.

C. Mock-Up Wall: Provide a mock-up wall as evaluation tool for product and installation workmanship.

D. Pre-Installation Meetings: Prior to beginning installation, conduct conference to verify and discuss substrate conditions, manufacturer's installation instructions and warranty requirements, and project requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Panels must be stored flat and kept dry before installation. A waterproof cover over panels and accessories should be used at all times prior to installation. Do not stack pallets more than two high. Refer to the information included on each pallet.

B. If panels are exposed to water or water vapor prior to installation, allow to completely dry before installing. Failure to do so may result in panel shrinkage at ship lap joints, and such action may void warranty.

C. Panels MUST be carried on edge. Do not carry or lift panels flat. Improper handling may cause cracking or panel damage.

D. Direct contact between the panels and the ground should be avoided at all times. It is necessary to keep panels clean during installation process.

1.7 WARRANTY

A. Provide manufacturer's 15-year warranty against manufactured defects in fiber cement panels. Additional 5-year extension available when refinished in year 14-15.

B. Provide manufacturer's 15-year warranty against manufactured defects in panel finish.

C. Warranty provides for the original purchaser. See warranty for detailed information on terms, conditions and limitations.

PART II: PRODUCTS

2.1 MANUFACTURERS

A. **Acceptable Manufacturers:**

- I. **Basis of Design** - NICHHA illumination series Fiber Cement Cladding.
- II. SWISSPEARL Carat series Fiber Cement Cladding.
- III. EQUITONE Natura series Fiber Cement Cladding.
- IV. CERACLAD Cashmere Smooth Series Fiber Cement Cladding.

1. Nichiha USA, Inc., 3150 Avondale Mill Rd, Macon, GA 301216, USA
 2. Nichiha Corporation, 18-19 Nishiki 2-chome Naka-ku, Nagoya, Aichi 460-8610, Japan.
- B. Acceptable Manufacturer's Representative: Nichiha USA, Inc., 6465 E. Johns Crossing, Suite 250, Johns Creek, GA 30097. Toll free: 1.866.424.4421, Office: 770.805.9466, Fax: 770.805.9467, www.nichiha.com.

1. Basis of Design Product: Nichiha Illumination Series.

- a. Profile colors: Designer-specified custom color (finished in U.S.).
- b. Profiles:
 1. AWP-1818 Panel: Smooth, no score lines.
 2. AWP-3030 Panel: Smooth, No score lines. Wider, soft-U chamfered edge at horizontal joints.
 - i. Do not pair the different sizes directly together.
- c. Accessory/Component Options:
 - i. Manufactured Corners with 3-1/2" returns for each profile size and color.
 - a. Do not use AWP-1818 Corners with AWP-3030 Panels.
 - ii. Aluminum trim options: Corner Key, Open Outside Corner, H-Mold, J-Mold, Compression Joint, Inside Corner
 1. Finish: Custom Color, Clear Anodized, or Primed.
 - iii. Essential Flashing System: Starter, Overhang.
 1. Finish: Matte black.
- d. Dimensions:
 1. AWP-1818: 455mm (17-7/8") (h) x 1,818 mm (71-9/16") (l).
 2. AWP-3030: 455mm (17-7/8") (h) x 3,030 mm (119-5/16") (l).
- e. Panel Thickness: 16 mm (5/8").
- f. Weight: AWP-1818: 35.27 lbs. per panel, AWP-3030: 57.32 lbs. per panel.
- g. Coverage: 8.88 sq. ft. per panel (1818), 14.81 sq. ft. per panel (3030).
- h. Factory sealed on six [6] sides.

C. Substitutions: Not permitted.

D. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

2.2 correct

- A. Fiber cement panels manufactured from a pressed, stamped, and autoclaved mix of Portland cement, fly ash, silica, recycled rejects, and wood fiber bundles.
- B. Panel surface pre-finished and machine applied.

COMPOSITE WALL PANELS

- C. AWP-1818 profiled along all four edges, such that both horizontal and vertical joints between the installed panels are ship-lapped.
- D. Factory-applied sealant gasket added to top and right panel edges; all AWP-1818 joints contain a factory sealant.

2.3 PERFORMANCE REQUIREMENTS:

- A. Fiber Cement Cladding – Must comply with ASTM C-1186, Type A, Grade II requirements:
 - 1. Wet Flexural Strength: Result: 1418 psi, Lower Limit: 1015 psi.
 - 2. Water Tightness: No water droplets observed on any specimen.
 - 3. Freeze-thaw: No damage or defects observed.
 - 4. Warm Water: No evidence of cracking, delamination, swelling, or other defects observed.
 - 5. Heat-Rain: No crazing, cracking, or other deleterious effects, surface or joint changes observed in any specimen.
- B. Mean Coefficient of Linear Thermal Expansion (ASTM E-228): Max 1.0×10^{-5} in./in. F.
- C. Surface Burning (CAN-ULC S102/ASTM E-84): Flame Spread: 0, Smoke Developed: 0.
- D. Wind Load (ASTM E-330): Contact manufacturer for ultimate test pressure data corresponding to framing type, dimensions, fastener type, and attachment clips. Project engineer(s) must determine Zone 4 and 5 design pressures based on project specifics.
 - 1. Minimum lateral deflection: L/120.
- E. Water Penetration (ASTM E-331): No water leakage observed into wall cavity.
- F. Steady-State Heat Flux and Thermal Transmission Properties Test (ASTM C-518): 16mm thick panel thermal resistance R Value of 0.47.
- G. Fire Resistant (ASTM E-119): The wall assembly must successfully endure 60-minute fire exposure without developing excessive unexposed surface temperature or allowing flaming on the unexposed side of the assembly.
- H. Ignition Resistance (NFPA 268): No sustained flaming of panels, assembly when subjected to a minimum radiant heat flux of $12.5 \text{ kW/m}^2 \pm 5\%$ in the presence of a pilot ignition source for a 20-minute period.
- I. Fire Propagation (NFPA 285): Wall assembly of Nichiha AWP, Ultimate Clips and Starter Track, Tyvek Commercial Wrap, 1/2" Densglass Gold Sheathing, 16" o.c. 18 gauge steel studs, mineral wool in-cavity insulation, and interior 5/8" Type X gypsum met the acceptance criteria of NFPA 285.
- J. Fire Propagation (CAN/ULC S-134): Wall assembly of Nichiha AWP, Ultimate Clips and Starter Track, Tyvek Housewrap, 5/8" FRT plywood, 16" o.c. 2x wood studs, fiberglass in-cavity insulation, and interior 5/8" Type X gypsum met the acceptance criteria of CAN/ULC S-134.

K. Drained and Back Ventilated Rainscreen (AAMA 509-14): System classifications: W1, V1.

L. Florida Building Code - Test Protocol HVHZ (TAS 202, 203): Horizontal Application Design Pressure: 95 psf, Vertical Application Design Pressure: 85 psf.

2.4 INSTALLATION COMPONENTS

A. Ultimate Clip System:

1. Starter Track:

- a. Horizontal Panel Installations - FA 700 – 3,030mm (l) galvalume coated steel.
- b. Vertical Panel Installations (AWP-3030 only) – FA 710T – 3,030mm (l) galvalume coated steel.

2. Panel Clips: JEL 778 “Ultimate Clip II” (10mm rainscreen for 16mm AWP) – Zinc-Aluminum-Magnesium alloy coated steel.

- a. Joint Tab Attachments (included) – used at all AWP-1818 panel to panel vertical joints. NOT used with AWP-3030 installations.

3. Corner Clips: JE 777C (10mm rainscreen for 5/8” AWP Manufactured Corners) -- Zinc-Aluminum-Magnesium alloy coated steel.

4. Single Flange Sealant Backer – FHK 1015 R (10mm) – 6.5’ (l) fluorine coated galvalume.

5. Double Flange Sealant Backer – FH 1015 R (10mm) – 10’ (l) fluorine coated galvalume.

6. Corrugated Spacer – FS 1005 (5mm), FS 1010 (10mm) – 4’ (l).

B. Aluminum Trim (optional, see Section 2.1): Choose primed trim finish as specified in finish schedule.

C. Essential Flashing System (optional, see Section 2.1):

1. Starter – main segments (3,030mm), inside corners, outside corners
2. Overhang – main segments (3,030mm), inside corners, outside corners, joint clips

D. Fasteners: Corrosion resistant fasteners, such as hot-dipped galvanized screws appropriate to local building codes and practices must be used. Use Stainless Steel fasteners in high humidity and high-moisture regions. Panel manufacturer is not liable for corrosion resistance of fasteners. Do not use aluminum fasteners, staples or fasteners that are not rated or designed for intended use. See manufacturer’s instructions for appropriate fasteners for construction method used.

E. Flashing: Flash all areas specified in manufacturer’s instructions. Do not use raw aluminum flashing. Flashing must be galvanized, anodized, or PVC coated.

F. Sealant: Sealant shall comply with ASTM C920, Class 35.

PART III: EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Fiber cement panels can be installed over braced wood, steel studs and sheathing including plywood, OSB, plastic foam (1" or less) or fiberboard sheathing. Fiber cement panels can also be installed over Structural Insulated Panels (SIP's), Concrete Masonry Units (CMU's) and Concrete Block Structures (CBS's) with furring strips, and Pre-Engineered Metal Construction. Insulated Concrete Forms (ICFs) require added measures. Consult with Nichiha Technical Services.
2. Allowable stud spacing: 16" o.c. maximum.
3. A weather resistive barrier is required when installing fiber cement panels. Use an approved weather resistive barrier (WRB) as defined by the 2015 IBC or IRC. Refer to local building codes.
4. Appropriate metal flashing should be used to prevent moisture penetration around all doors, windows, wall bottoms, material transitions and penetrations. Refer to local building codes for best practices.

B. Examine site to ensure substrate conditions are within alignment tolerances for proper installation.

C. Do not begin installation until unacceptable conditions have been corrected.

D. Do not install panels or components that appear to be damaged or defective. Do not install wet panels.

3.2 TOLERANCE

A. Wall surface plane must be plumb and level within +/- 1/4 inch in 20 feet in any direction.

1. One layer of Nichiha 5mm (~3/16") Spacer may be used as shim.

3.3 INSTALLATION

A. General: Install products in accordance with the latest installation guidelines of the manufacturer and all applicable building codes and other laws, rules, regulations and ordinances. Review all manufacturer installation, maintenance instructions, and other applicable documents before installation.

1. Consult with your local dealer or Nichiha Technical Department before installing any Nichiha fiber cement product on a building higher than 45 feet or three stories or for conditions not matching prescribed standard installation guide requirements and methods. A Technical Design Review (TDR) process is available to evaluate project feasibility.

2. *Vertical Control/Expansion Joints* are required with AWP-1818, for walls wider than 30 feet, within 2-12 feet of outside corners finished with metal trim *and* approximately every 30 feet thereafter.

A. *Vertical Control/Expansion Joints* are required at each AWP-3030 vertical joint, or H-Mold trim may be used instead.

3. *Horizontal/Compression Joints* are required for multi-story installations of AWP. Locate joints at floor lines. Joints are flashed minimum ½" breaks. Do not caulk. Refer to installation guide(s).

A. Wood framed buildings of three or more floors require a compression joint at each floor.

B. Steel framed buildings (including reinforced concrete core with LGMF exterior walls) of more than three floors (or 45 feet) require a compression joint every 25 feet at a floor line.

B. Panel Cutting

1. Always cut fiber cement panels outside or in a well ventilated area. Do not cut the products in an enclosed area.

2. Always wear safety glasses and NIOSH/OSHA approved respirator whenever cutting, drilling, sawing, sanding or abrading the products. Refer to manufacturer SDS for more information.

3. Use a dust-reducing circular saw with a diamond-tipped or carbide-tipped blade.

a. Recommended circular saw: Makita 7-1/4" Circular Saw with Dust Collector (#5057KB).

b. Recommended blade: Tenryu Board-Pro Plus PCD Blade (#BP-18505).

c. Shears (electric or pneumatic) or jig saw can be used for complicated cuttings, such as service openings, curves, radii and scrollwork.

4. Silica Dust Warning: Fiber cement products may contain some amounts of crystalline silica, a naturally occurring, potentially hazardous mineral when airborne in dust form. Consult product SDS or visit <https://www.osha.gov/dsg/topics/silicacrystalline/>.

5. Immediately clean dust from cut panels as it may bind to the finish.

3.4 CLEANING AND MAINTENANCE

A. Review manufacturer guidelines for detailed care instructions.

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. Adhered PVC membrane roofing system.
2. Vapor retarder.
3. Roof insulation.
4. Roof edge system(s).
5. Roof expansion joints

B. Related Sections:

1. Division 06 Section "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
2. Division 07 Section "Preparation for Re-Roofing" for recover board beneath new membrane roofing.
3. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
4. Division 07 Section 'Air, Vapor, [& Water] Barrier Membrane' for continuity of building envelope barriers.
5. Division 07 Section "Roof Accessories"
6. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

- A. PVC: Polyvinyl Chloride.
- B. Roofing Terminology: See ASTM D 1079 and glossary of National Roofing Contractors Association [NRCA] "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 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 according to ASCE/SEI 7.

- D. State Building Code Performance Requirements:
 - 1. Risk Category: **2**
 - 2. Basic Wind Speed **124**
 - 3. Exposure Category: **C**

- E. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals' markings.
 - 1. Fire/Windstorm Classification: Class 1A-90 minimum.
 - 2. Hail Resistance: Moderate.

- F. Roofing system to meet the roof requirements as follows: install per manufacturer's recommendations and requirements for a weather tight installation with a 30 year warranty, 2 year installer warranty, meeting at the minimum, the requirements of the Factory Mutual Insurance Criteria for FM Data Sheet 1-28 'Wind Design', Sheet 1-29 'Roof Deck Securement and Above Deck Roof Components,' and the State Building Code.

- G. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency or meeting the basis of design.

- H. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope and/or steep-slope roof products.

1.5 SUBMITTALS

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

- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Base flashings and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing and fastening spacings and patterns for mechanically fastened roofing components [insulation board, etc.]
 - 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
 - 5. Roof fascia, parapet cap, and other terminations
 - 6. Roof accessories installation penetration flashing details,
 - 7. Other required roof accessories installation details.

- 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 or rolls.
 - 4. Metal termination bars.
 - 5. Six insulation fasteners of each type, length, and finish.
 - 6. Six roof cover fasteners of each type, length, and finish.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Specifications
- B. Product Data Sheets
- C. Material Safety Data Sheets
- D. FM/UL listing/approvals
- E. UL Environmental validation of recycling claims
- F. Qualification Data: For qualified Installer and manufacturer.
- G. Manufacturer Certificate: Signed by roofing manufacturer certifying that membrane roofing system complies with requirements specified in "Performance Requirements" Article.
 - 1. Submit evidence of complying with performance requirements.
- H. 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.
- I. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.
- J. Roof manufacturer's design calculations indicating wind uplift design requirements and fastener spacings required.
- K. Maintenance Data: For roofing system to include in a maintenance manual.
- L. Field quality-control reports.
- M. Warranties: Sample of special warranties, manufacturers, installers, others as indicated.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For membrane roofing system to include in maintenance manuals.
- B. Final Manufacturer's letter stating Roofing Contractor has completed all installation work; fastener spacings are installed per manufacturer and/or FM requirements [the more stringent]; and Manufacturer's work remaining list or correction list.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed, Class A, for membrane roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- C. Source Limitations: Obtain components including roof insulation and fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.
- D. Exterior Fire-Test Exposure: ASTM E 108, 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.
- E. 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.

- F. Pre-installation Roofing Conference: Conduct conference at Project site.
1. Meet with Owner, Architect, Owner'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.

1.9 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.

1.10 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that

fail in materials or workmanship within specified warranty period.

1. Special warranty includes membrane roofing, roof edge system, base flashings, roof insulation, fasteners, and other components of membrane roofing system.
 2. Warranty Period: 30 years, from date of Substantial Completion. (NO DOLLAR LIMIT), including 100 MPH wind speed coverage as measured ten meters above grade.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, fasteners, vapor retarders, and walkway products, for the following warranty period:
1. Warranty Period: Two years from date of Substantial Completion.

2.PRODUCTS

2.1 PVC MEMBRANE ROOFING

- A. Basis of Design: 'Carlisle' FleeceBACK PVC Adhered Roofing System incorporates maximum 10' wide, 80-mil thick Polyester reinforced polyester membrane (PVC) membrane (white). **The new roof system tie-in must comply and maintain the existing John's Manville roofing system and warranties.**
1. PVC Sheet: ASTM D 4434, Type III, fabric reinforced.
 2. UL Class A at high sloped membrane roofing.
 3. Additional Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sarnafil, Sika Corporation.
 - b. Carlisle SynTec Incorporated.
 - c. Cooley Engineered Membranes, Division of Colley Group.
 - d. GAF Materials Corporation.
 - e. GenFlex Roofing Systems.
 - f. Johns Manville.
 4. Thickness: 80 mils (13Car5mm), nominal, reinforced Carlisle FleeceBACK PVC
 5. Sheet Size: 10' x 75'.
 6. Exposed Face Color: White, with Cool roof rating Council. White, initial solar reflectance of 0.86, emittance of 0.89, and solar reflective index (SRI) of 108

2.2 METAL EDGING AND MEMBRANE TERMINATIONS

- A. Basis of Design: Hickman Engineered System or similar system provided by the roofing system manufacturer meeting the performance requirements for the full roof system warranty.
- B. Custom edge and coping cap: a metal edge/cap system with 22 gage cleats and 040 thick aluminum to match existing .
- C. Accessories: Corners shall be fabricated by roof edge manufacturer as factory fabricated, mitered corners with nominal 12 inch (305 mm) leg lengths.

2.3 AUXILIARY MEMBRANE ROOFING MATERIALS

- A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
 2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Multipurpose Construction Adhesives: 70 g/L.
 - c. Fiberglass Adhesives: 80 g/L.
 - d. Low VOC Bonding Adhesive: 250 g/L.
 - e. Single-Ply Roof Membrane Sealants: 450 g/L.
 - f. Nonmembrane Roof Sealants: 300 g/L.
 - g. Sealant Primers for Nonporous Substrates: 250 g/L.
 - h. Sealant Primers for Porous Substrates: 775 g/L.
- B. Sheet Flashing: Flash all walls and curbs with Sure-Flex reinforced membrane. Non-Reinforced membrane shall be limited to inside and outside corners, field fabricated pipe seals, scuppers and Sealant Pockets where the use of pre-molded accessories are not practical. Terminate the flashing in accordance with an appropriate Carlisle Termination Detail.
- C. Bonding Adhesive: Manufacturer's low VOC solvent based.
- D. Slip Sheet: Manufacturer's standard, of thickness required for application.
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- F. Metal Hurricane Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- G. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, pre-punched.
- H. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
- I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.
- J. Enhanced perimeter sheets: Provide Manufacturer's requirements for enhanced perimeter sheets where indicated.
- 2.4 SUBSTRATE BOARDS
- A. Substrate Board: When indicated [on the drawings or required by the indicated roof UL reference] to be ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, Type X, 5/8 inch (16 mm) thick as specifically indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, the following:
 - a. Georgia-Pacific Corporation; Dens Deck or approved equal.
- B. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

2.5 VAPOR RETARDER

- A. Self-Adhesive vapor barrier [direct to metal deck]: Unless otherwise indicated, provide reinforced composite aluminum foil, cold applied, self-adhesive SBS backing roll material equal to VapAir Seal MD as manufactured by Carlisle.

2.6 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by TPO membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation. [FM 4450, and/or FM 4470]. Provide multiple insulation layers for the required R-value in excess of R-12, and/or thickness indicated over 2 inches.
 1. When one layer of insulation is required or indicated, provide Composite Polyisocyanurate Board Insulation board with the ½" minimum high density polyiso cover board
 2. When two (2) layers of insulation are required due to thermal barrier insulation required, unless indicated otherwise, provide Composite Polyisocyanurate Board Insulation board with the high density polyiso cover board top for the top layer with the base layer to be Polyisocyanurate Board Insulation.
- B. Polyisocyanurate Board Insulation: When indicated, provide ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
- C. Composite Polyisocyanurate Board Insulation: When indicated, provide ASTM C 1289, Type II, Class 1, Grade 2 with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
 1. Type VII, glass mat faced gypsum board facer, 1/4 inch (6 mm) thick.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.7 COVER BOARDS

- A. Cover Board: When indicated [on the drawings or required by the indicated roof UL reference] to be ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, Type X, 5/8 inch (16 mm) thick as specifically indicated.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, the following:
 - a. Georgia-Pacific Corporation; Dens Deck or approved equal.
- B. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening cover board panel to roof deck.

2.8 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
- B. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
 - 1. Fasteners: HPX Fasteners and Piranha Plates.

2.9 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
- B. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and/or cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphalt, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
- D. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
- E. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

2.10 WALKWAYS

- A. Flexible Walkways (unless otherwise indicated): Provide Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer. Fully welded on all perimeter edges.

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 all roof surfaces are free of water, ice and/or snow and other conditions that would impact or impede roof system component installation.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to 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. 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.
- D. Where acoustical deck is indicated, install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking," according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry.
- E. Install deck flute insulation

3.3 SUBSTRATE BOARD

- A. Install substrate board, when required, 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 according to recommendations in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

3.4 VAPOR-RETARDER INSTALLATION

- A. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system. Seal to wall air and vapor barrier system.
- B. Self-Adhesive vapor barrier Basis of Design: [direct to deck]: Prepare surface receiving the membrane as required by the roofing manufacturer. Provide end lap additional support layer of 6 inch minimum membrane strip or flat metal plate per manufacturer's installation requirements. All edges to be overlapped a minimum of 2".
- C. Polyethylene Film where indicated: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.
 1. Continuously seal side and end laps with tape or adhesive.
- D. Laminate Sheet where indicated: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to substrate as follows:
 1. Apply adhesive at rate recommended by vapor-retarder manufacturer. Seal laps with adhesive.

3.5 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 insulation under area of roofing to achieve the required thickness and/or R-value. Where overall insulation thickness is 2.5 inches (62 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
 - 1. Where installing composite and non-composite insulation in two or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
- D. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- E. 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 (6 mm) with insulation.
 - 1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
- F. Mechanically Fastened Insulation: When indicated, Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
 - 2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
 - 3. Fasten [all] concealed layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 - 4. Set top layer of insulation in ribbons of bead-applied insulation adhesive or a uniform coverage of full –spread insulation adhesive as required by the roof system manufacturer to achieve the wind design performance requirements, firmly pressing and maintaining insulation in place.
- G. Adhered Insulation, Top Layer over concealed insulation layers.
 - 1. Set each layer of insulation in ribbons of bead-applied insulation adhesive or a uniform coverage of full –spread insulation adhesive as required by the roof system manufacturer to achieve the wind design performance requirements, firmly pressing and maintaining insulation in place.
- H. When using separated cover board, 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 (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck.
 - 1. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
 - 2. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.6 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere membrane roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions and according to ASTM D5036. Unroll membrane roofing and allow to relax before installing.
- B. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. 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.
- D. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.
- E. Apply membrane roofing with side laps shingled with slope of roof deck to avoid bucking of water.
- F. Apply the applicable Carlisle bonding adhesive to the exposed underside of the membrane and the corresponding substrate area with required rollers at the required rates required by the manufacturer.
- G. Allow adhesive to dry until tacky and roll coated membrane into coated substrate and avoid wrinkling.
- H. Brush down the bonded section of membrane immediately with soft bristle push broom.
- I. Fold back the un-bonded section of sheet and repeat the bonding procedure.
- J. Install adjoining membrane sheets in the same manner, overlapping edges a minimum of 3 inches to provide for a minimum of 2 inches hot air weld. All splices to be shingled to avoid bucking of water.
- K. Hot air weld the membrane sheets a minimum of 2 inches with an automatic hot air welding machine set to the temperature required by the roofing manufacturer.
- L. Where membrane has been exposed to the elements for 5 days or more, must be prepared with manufacturer's required cleaners and prepared and wiped down as required by the membrane manufacturer prior to hot air welding.
- M. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
- N. Spread sealant or mastic bed as recommended by the membrane manufacturer [to seal membrane water tight to roof drain bonding], over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
- O. Install membrane roofing and auxiliary materials to tie in to existing membrane roofing to maintain weather-tightness of transition and to not void warranty for existing membrane roofing system.
- P. Additional membrane securement required at the perimeter of each roof level, roof section, expansion joint, curb, skylight, interior wall, penthouse, etc. at any change which exceeds 2 inches per horizontal foot and at all other penetrations in accordance with the membrane manufacturer's published details or specifications.
- Q. Install Hurricane Bar at 48 inches up slope from roof edge and flash in with 8 inch minimum cover membrane as required by manufacturer to achieve the required warranty and/or wind design requirements.

3.7 MEMBRANE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories such as Sure-Weld reinforced

membrane, and adhere to substrates according to membrane roofing system manufacturer's written instructions and as indicated herein and in conformance with the construction drawings. When conflicts occur review with the Architect for resolution.

- B. Non-reinforced membrane may be used only at inside and outside corners, field fabricated pipe seals, scuppers and sealant pockets where the use of pre-molded accessories are not practical. Terminate the flashing in accordance with an appropriate Carlisle Termination Detail in conformance with the design direction indicated herein and as detailed. Where conflicts occur review with the Architect for resolution.
- C. 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.
- D. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- E. 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.
- F. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.
- G. The minimum allowable vertical flashing required is 12 inches from top of horizontal membrane field to the termination bar or bottom of metal counter flashing. Bonding adhesive is required at all vertical surfaces such as walls, curbs, and pipes.

3.8 METAL EDGE TRIM

- A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the owner's representative and Carlisle. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing due to incomplete flashings, the affected area shall be removed and replaced at the contractor's expense.
 - 1. Metal flashings shall be formed and installed per the contract documents.
 - 2. The nailing flange of the metal shall be a minimum of 4 in. (102 mm) in width.
 - 3. All metal flashings shall be fastened into solid wood nailers with two rows of post galvanized flat head annular ring nails, 4 in. (102 mm) on center staggered.
 - 4. Fasteners shall penetrate the nailer a minimum of 1 in. (25 mm). Note: hold back nails 1 in. (25 mm) from outside edge of Sarnacled metal so that membrane and/or flashing can be adhered or welded to the metal completely covering all nails by 1 in. (25 mm) minimum.
 - 5. Metal shall be installed to provide adequate resistance to bending and allow for normal thermal expansion and contraction.
 - 6. Adjacent sheets of metal shall be spaced ¼ in. (7 mm) apart. Metal shall be secured at joint.
 - 7. The joint shall be covered with 2 in. (51 mm) wide aluminum foil tape. A 4 in. (102 mm) wide strip of Sarnafil G410 flashing membrane shall be adhered or hot air welded over the joint.
 - 8. 24-gauge (minimum) hook strips are required behind the metal. The hook strip is to be fastened 12 in. (305 mm) on center into the wood nailer or the masonry wall. Alternatively the metal can be face fastened with grommets face screw fasteners.
- B. Exercise caution at perimeter of roof. Workers shall follow OSHA safety procedures.
- C. Install fascia metal, backer plate and/or metal hook strip in accordance with Factory Mutual's Loss Prevention Data Sheet 1-49 and roofing system manufacturer's requirements to meet the wind design performance requirements.

3.9 WALKWAY INSTALLATION

- A. Flexible Walkways where indicated: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner may engage a qualified independent testing agency to perform inspections.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- C. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
- D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTING AND CLEANING

- A. 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 Owner.
- B. 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 according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 54 25

SECTION 07 60 00 - FLASHING AND SHEET METAL

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. Metal flashing and counter flashing and related expansion joints.
2. Metal gravel stops, trim and related expansion joints.
3. Metal gutters and downspouts (rain drainage) not specified elsewhere.
4. Metal soffit systems, vented and unvented.
5. Metal drip edge.
6. Miscellaneous metal trim, flashing, etc. not specified elsewhere.

1.3 RELATED WORK UNDER OTHER SECTIONS:

1. Division 04 Section Masonry work Flashing (fabric, composite, and/or metal) built in
2. Division 05 Section Expansion joint covers.
3. Division 07 Section Roof Membrane Systems
4. Division 07 Section Asphalt Single Roof
5. Division 07 Section Standing Seam Metal Roofing with integral Gutters and downspouts
6. Division 07 Section Insulated and Non-Insulated metal panel systems.
7. Division 08 Sections for Fenestration where sill or other flashing is required.
8. Division 09 Section Painting of exposed metal work above main roof line.
9. Division 23 Section Roof vent flashings.

1.4 SUBMITTALS:

- A. Product Data: For information only, submit copies of specifications, installation instructions and general recommendations by the manufacturer of flashing and sheet metal materials. Include published data or certified test data for each material showing compliance with the requirements.
- B. Samples: Submit 12" square samples of each specified metal which is to be exposed with a shop finish, as flashing, trim or rain drainage. Samples will be reviewed by Architect for color and texture only. Compliance with other requirements is the exclusive responsibility of the Contractor.
- C. Certificate: Submit certification indicating metal coping, fascias and gravel stop systems comply with ASNI/SPRI ES-1 "Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems".
- D. Mock-up: Submit 4 foot long section of metal fascia, fabricated from approved metal, indicating selected profile, attachment system, jointing and seaming system.

1.5 JOB CONDITIONS:

- A. Do not proceed with the installation of flashing and sheet metal work until curb and substrate construction, cant strips, blocking, reglets and other construction to receive the work is completed.
- B. Examine the substrate and the conditions under which flashing and sheet metal work is to be performed, and do not proceed with the work until unsatisfactory conditions have been corrected.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Exposed Sheet Metal: (Including gravel stops and rain drainage.)
 - 1. Aluminum Sheet: Prefinished; .032" (20 gauge; 26,000 PSI yield strength); specially tempered to allow radius bends and forming without finish cracks.
 - a. Finish: Clean metal and apply conversion coating as per ASTM B 449. Prime with epoxy and finish with 0.8 dry mil coating of fluoropolymer in color as selected. (Provide 0.5 dry mil acrylic coating on concealed side.)
 - b. Texture: Smooth or embossed, as selected.
 - c. Warranty: Provide copies of written twenty (20) year warranty covering color fading, chalk and film integrity.
 - 2. Stainless Steel Sheet: AISI Type 302/304 stainless steel or strip, complying with ASTM A 167; dead soft; No. 2D conventional dull finish; or,
- B. Zinc-Tin Alloy-Coated Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, of minimum uncoated weight (thickness) indicated; coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Revere Copper Products, Inc.; FreedomGray.
- C. Concealed Sheet Metal:
 - 1. Stainless Steel Sheet: AISI Type 302/304 stainless steel or strip, complying with ASTM A 167; dead soft; 28 gauge (0.015 inches thick); No. 2D conventional dull finish; or,
 - 2. Copper Sheet: Cold-rolled sheet copper, complying with ASTM B 370, except soft temper; 28 gauge (16 oz./sq. ft.), CDA 2B (bright) finish.
- D. Miscellaneous Materials:
 - 1. For metal work, provide the type solder and fasteners recommended by the producer of the metal sheets.
 - 2. For non-metallic work, provide the types of substrate primers, adhesives, tapes and fasteners recommended by the producer of the non-metallic items.
 - 3. Roofing Cement: ASTM D 2822.
 - 4. Bituminous Coating: FS TT-C-494, or Mil-C-18480, or SSPC-Paint 12, cold-applied bituminous mastic, compounded for 15-mil dry film thickness coating.

5. Glass-Fiber Mesh Fabric: 20-by-20 or 20-by-30 mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration; in the following color. Comply with ASTM D 3656. Color as selected.
- E. Fabricated Metal Flashing, Rain Drainage and Trim:
1. Shop fabricate metal flashing, trim, expansion joints, gutters, downspouts, conductor heads, scuppers, fascia, splash pans and similar items to comply with profiles and sizes shown, and to comply with standard industry details by SMACNA in the "Architectural Sheet Metal Manual". Provide watertight seams, and fold back metal to form a hem on the concealed side of exposed edges, where required. Fabricate work from the metal specified above.
- F. Drip Edge:
1. Provide prefinished, prefabricated aluminum drip edges.
- G. Gutters:
1. Provide custom fabricated gutters and downspouts.
 2. Prefinished aluminum gutters, gauge as previously specified.
 3. Prefinished downspouts, gauge as previously specified.
- H. Soffit System:
1. Provide prefinished, prefabricated, vented and unvented aluminum soffit system, equal to Alucobond, non-insulated panel.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

- A. Comply with manufacturer's instructions and recommendations for handling and installation of flashing and sheet metal work.
- B. Performance: Coordinate the work with other work for the correct sequencing of items which make up the entire membrane or system of weatherproofing or waterproofing and rain drainage. It is required that the flashing and sheet metal work be permanently watertight, and not deteriorate in excess of manufacturer's published limitations.

3.2 INSTALLATION OF METAL WORK:

- A. Comply with details and profiles as shown, and SMACNA "Architectural Sheet Metal Manual" recommendations for installation of the work.
- B. For non-moving seams provide soldered flat-lock seams. Comply with metal producers' recommendations for tinning, soldering and cleaning the joints.
- C. Provide for thermal expansion of all exposed sheet metal work exceeding 15'-0" running length.

1. Valleys and Gutters: 40'-0" maximum spacing, and located at high points in drainage system wherever possible.
 - a. Reduce above spacing to 30'-0" for aluminum or zinc alloy valleys and gutters.
 2. Flashing and Trim: 10'-0" maximum spacing, and located 2'-0" from corners and intersections.
- D. Conceal fasteners and expansion provisions. Fold back edges on concealed side of exposed edges, to form a hem. Where fasteners cannot be concealed, provide non-ferrous fasteners.
- E. Insert flashings into reglets, if shown. Anchor by mechanical means, including driven wedges of lead or other compatible metal, spaced 2'-0". Seal the joint with sealant as indicated.
1. Refer to 0 790 00 section for sealants.
- F. Separate stainless steel work from dissimilar metals and from wood and cementitious materials. Separate with a course of polyethylene underlayment wherever possible. Apply a 15-mil dry film thickness bituminous coating to either the substrate or stainless steel where underlayment cannot be used for separation.
- G. Separate copper work from dissimilar metals by a 15-mil dry-film thickness bituminous coating, or by a heavy tinning of solder at spot-contacts.
- H. Aluminum Work: Bed base members in roofing cement. Anchor and seal in accordance with manufacturer's instructions. Clean exposed surfaces promptly to prevent the start of non-uniform oxidation or electrolytic action.
1. Apply 15-mil dry film thickness bituminous coating to concealed aluminum surfaces which will be in contact with cementitious surfaces, dissimilar metals, wood or other absorptive substrates.
- I. Fabricate, support and anchor rain drainage to withstand thermal expansion stresses and full loading by water or ice, without damage, deterioration or leakage.

END OF SECTION 07 60 00

SECTION 07 92 00 - JOINT SEALANTS

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: The extent of each type of joint sealer is indicated. Provide "sealant" for all exterior joints, certain indicated interior joints, and where "mastic" is indicated. Provide "calking" at all remaining interior joints.
- B. The required applications include, but are not limited to the following:
 - 1. Pavement and sidewalk joints subjected to foot traffic.
 - 2. Exterior building wall joints.
 - 3. Flashing and coping joints.
 - 4. Miscellaneous concrete construction joints.
 - 5. Masonry control joints.
 - 6. Floor (interior) joints.
 - 7. Sealant between floor and plumbing fixtures.
 - 8. Partition and ceiling joints.
 - 9. Joints at openings and indicated frames or subframes.
 - 10. Equipment and isolation joints.
 - 11. Security sealant.

1.3 PRE-INSTALLATION MEETING:

- A. Pre-Installation Meeting: Meet at the project well in advance of the time scheduled for work, (a minimum of one week), and review requirements for the work and conditions which could possibly interfere with successful performance of the work. Require all parties concerned with the work, or required to coordinate with it, or to protect it thereafter, to attend the meeting, including:
 - 1. Owner or Representative
 - 2. General Contractor
 - 3. Installer
 - 4. Manufacturer(s) Representatives
 - 5. Architect

1.4 QUALITY ASSURANCE:

- A. At the Owner's option, testing of depth of joint material may be undertaken to insure compliance with the specification and conformance to manufacturer's specifications and recommendations for joint design. If the joint fails to comply with design requirements, the Contractor shall pay for the cost of testing and replacement of all affected joints.

1.5 SUBMITTALS:

A. Product Data:

1. For information only, submit copies of manufacturer's specifications, recommendations and installation instructions for each type of material required. Include manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the applications shown.

B. Samples:

1. Submit samples of each color required (except black) for each type of joint sealer exposed to view. Install sample between two strips of material similar to or representative of typical surfaces where sealer will be used, held apart to represent typical joint widths. Samples will be reviewed for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

C. Guarantee:

1. Submit copies of written two-year guarantee agreeing to repair or replace joint sealers which fail to perform as air-tight and water-tight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated.
 - a. Provide guarantee signed by the Installer and Contractor.

1.6 JOB CONDITIONS:

- A. Examine the joint surfaces and backing, and their anchorage to the structure, and the conditions under which the joint sealer work is to be performed. Do not proceed with the joint sealer work until unsatisfactory conditions have been corrected.
- B. Weather Conditions: Do not proceed with installation of sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation. Proceed with the work only when weather conditions are favorable for proper cure and development of high early bond strength. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installation temperature range.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL:

- A. Colors: For exposed materials provide color as indicated or, if not indicated, as selected from manufacturer's standard colors. For concealed materials, provide the natural color which has the best overall performance characteristics.
- B. Hardness: As recommended by manufacturer for application shown.

- C. Modulus of Elasticity: Provide the lowest available modulus of elasticity which is consistent with exposure to weathering, indentation, vandalism, abrasion, support of loading, and other requirements.
- D. Compatibility: Before purchase of each required material, confirm its compatibility with each material it will be exposed to in the joint system.
- E. Size and Shape: As shown or, if not shown, as recommended by the manufacturer for the type and condition of joint, and for the indicated joint performance or movement.
- F. Grade of Sealant: For each application, provide the grade of sealant (non-sag, self-leveling, no-track, knife grade, preformed, etc.) recommended by the manufacturer for the particular condition of installation (location, joint shape, ambient temperature, and similar conditions), to achieve the best possible overall performance. Grades specified herein are for normal condition of installation.

2.2 SEALANTS (See Sealant Schedule at end of Section for specific use of sealants.)

A. Urethanes:

1. Type "A1": Two-Part Urethane: Self-Leveling, ASTM C920, Type M, Grade P, Class 25. (Fed. Spec. TT-S-00227E Type I, Class A.)
 - a. Chem-Calk CC-550, by Bostik.
 - b. Vulkem 245, by Tremco.
 - c. Vulkem 255, Wide-Joint, by Tremco.
 - d. NR-200 Urexpam, by Pecora Corporation.
 - e. Sikaflex-2c NS/SL, by Sika Corporation.
 - f. SL-2, by Sonneborn
2. Type "A2": Two-Part Urethane: Non-Sag, ASTM C920, Type M, Grade NS, Class 25. (Fed. Spec. TT-S-00227E Type II, Class A.)
 - a. Chem-Calk 500, by Bostik.
 - b. Vulkem 227, by Tremco.
 - c. Dynatrol II, by Pecora Corporation.
 - d. Sikaflex-2c NS/SL, by Sika Corporation.
 - e. Sonolastic NP 2, by Sonneborn Building Products, ChemRex Inc.
 - f. Dymeric, by Tremco
3. Type "A3": One-Part Urethane: Self-Leveling, ASTM C920, Type S, Grade P, Class 25. (Fed. Spec. TT-S-00230C Type I, Class A.)
 - a. Vulkem 45, by Tremco.
 - b. Urexpam NR-201, by Pecora Corporation.
 - c. Sonolastic SL1, by Sonneborn Building Products, ChemRex Inc.
4. Type "A4": One-Part Urethane: Non-Sag, ASTM C920, Type S, Grade NS, Class 25. (Fed. Spec. TT-S-00230C Type II, Class A.)
 - a. Chem-Calk 900, by Bostik.
 - b. Vulkem 116, by Tremco.
 - c. Sonolastic NP I, by Sonneborn Building Products, ChemRex Inc.
 - d. Dymonic, by Tremco.

B. Silicones:

1. Type "B1": One-Part Silicones: ASTM C920, Type S, Grade NS, Class 25. Vertical Surfaces Only.
 - a. 795 Silicone Structural Glazing, Glazing, and Weatherproofing Sealant, by Dow Corning.
 - b. 864 Architectural Silicone, by Pecora Corporation.
 - c. Sonolastic 150 Silyl Terminated polyether, by Sonneborn
 - d. Spectrem 3, by Tremco.
2. Type "B2": One-Part Silicones: ASTM C920, Type S, Grade NS, Class 25. Vertical Surfaces Only.
 - a. 795 Silicone Structural Glazing, Glazing, and Weatherproofing Sealant, by Dow Corning. (colors only)
 - b. 999-A, Dow Corning.
 - c. Construction 1200 Sealant, General Electric Company.
 - d. Sonolastic 150 Silyl Terminated polyether, by Sonneborn (Not for wet glazing)
 - e. Spectrem 2, by Tremco.
3. Type "B3": One-Part Silicones: ASTM C920, Type S, Grade NS, Class 25. Vertical Surfaces Only.
 - a. 795 Silicone Structural Glazing, Glazing, and Weatherproofing Sealant, by Dow Corning. (colors only)
 - b. Construction 1200 Sealant, General Electric Company.
 - c. 999-A, Dow Corning.
 - d. 864 Architectural Silicone, by Pecora Corporation. (colors only)
 - e. Sonolastic 150 Silyl Terminated polyether, by Sonneborn
 - f. Spectrem 1, by Tremco.
4. Type "B4": One-Part Silicones: ASTM C920, Type S, Grade NS, Class 25.
 - a. 786 Mildew Resistant Silicone Sealant, Dow Corning.
 - b. SCS 1700 Sanitary Sealant, General Electric.
 - c. 898 Silicone Sanitary Sealant, Pecora Corporation.
 - d. Omniseal or Omniplus (Sanitary applications), by Sonneborn
 - e. Tremsil, by Tremco.

C. Acrylics, Latex: (For interior use only.)

1. Type "C1": One-Part Acrylic Latex, Non-Sag, ASTM-C-834-76.
 - a. Chem-Calk 600, by Bostik.
 - b. LC-130, by MACCO Adhesives, The Glidden Company.
 - c. Easa-ply ALS, by W. R. Meadows, Inc.
 - d. AC-20+Silicone Acrylic Latex, by Pecora Corporation.
 - e. Sonolac, Sonneborn Building Products, ChemRex Inc.

D. Acoustical Sealants:

1. Type "D1":
 - a. AC-20 FTR Acoustical and Insulation Sealant, by Pecora Corporation.

- b. 60+ Unicrylic, by Pecora Corporation.
- c. Sheetrock Acoustical Sealant, by United States Gypsum.

E. Butyls:

- 1. Type "E1": One-Part Butyl, Non-Sag, FS TT-S-1657.
 - a. Chem-Calk 300, by Bostik.
 - b. BC-158 Butyl Rubber, by Pecora Corporation. (ASTM C1085)

F. Preformed Compressible & Non-Compressible Fillers:

- 1. Type "F1": Backer Rod - Closed cell polyethylene foam:
 - a. HBR Backer Rod, by Nomaco.
 - b. #92 Greenrod, by Nomaco.
 - c. Sonolastic Closed-Cell Backer Rod, Sonneborn Building Products, ChemRex Inc.
 - d. Soft Cell Backer Rod (Non-gassing), by Sonneborn.
- 2. Type "F2": Backer Rod - Open cell polyurethane foam:
 - a. Denver Foam, by Backer Rod Mfg. Inc.
 - b. Foam Pack II, by Nomaco.
- 3. Type "F3": Neoprene compression seals:
 - a. WE, WF, and WG Series, by Watson Bowman & Acme Corp.
 - b. Will-Seal 150 Precompressed Expanding Foam Sealants, by Will-Seal, a Division of Illbruck.
- 4. Type "F4": Butyl Rod:
 - a. Kirkhill Rubber Co. (714)529-4901.
- 5. Type "G1":
 - a. Bond Breaker Tape: Polyethylene tape of plastic as recommended by sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate of joint filler must be avoided for proper performance of sealant

2.3 PAVING SEALANTS:

- A. Type "P1": Two-Part Urethane: Self-Leveling, ASTM C920, Type M, Grade P, Class 25.
 - 1. Vulkem 202, by Tremco. (Jet Fuel Resistant) (FS SS-S-200D, Type H only)
 - 2. NR-300 Urexpan, by Pecora Corporation. (FS SS-S-200E)
 - 3. Sonomeric 2, by Sonneborn
- B. Type "P2": One-Part Urethane: Self-Leveling, ASTM C920, Type S, Grade P, Class 25.
 - 1. Sonomeric 1 Sealant, by Sonneborn Building Products, ChemRex Inc. (FS SS-S-200E)
 - 2. Vulkem 45, by Tremco.
- C. Type "P3": Epoxy Joint Filler (Heavy Traffic Areas)

1. Epolith P or Epolith G, by Sonneborn

2.4 SECURITY SEALANT

- A. Manufacturer: Pecora Corporation, 165 Wambold Road, Harleysville, PA 19438, Phone: 215-723-605, 800-523-6688, Fax: 215-721-0286, Website:www.pecora.com.
- B. Product: Dynapoxy EP-1100, a two-part, non-sag chemically curing epoxy adhesive/sealant, specially formulated for security areas and other areas where tenacious bonding properties and durability are required.

2.5 MISCELLANEOUS ACCESSORIES:

- A. Joint Primer/Sealer: Provide the type of joint primer/sealer recommended by the sealant manufacturer for the joint surfaces to be primed or sealed.
- B. Bond Breaker Tape: Polyethylene tape or other plastic tape recommended by the sealant manufacturer to be applied to sealant-contact surfaces where bond to the substrate or joint filler must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.
- C. Sealant Backer Rod: Compressible rod stock of polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam; or other flexible, permanent, durable non-absorptive material as recommended by the sealant manufacturer.

PART 3 - EXECUTION

3.1 Manufacturer's Instructions:

1. Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.
- B. Joint Preparation:
 1. Clean joint surfaces immediately before installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealant or caulking compound. Etch concrete and masonry joint surfaces and roughen vitreous or glazed joint surfaces as recommended by sealant manufacturer.
 2. Prime or seal the joint surfaces where recommended by the sealant manufacturer. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

3.2 INSTALLATION:

- A. Set joint filler units at proper depth or position in the joint to coordinate with other work, including the installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between the ends of joint filler units.
- B. Install sealant backer rod for liquid elastomeric sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for the application shown.

- C. Install bond breaker tape where required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.
- D. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Fill sealant rabbet to a slightly concave surface, between a horizontal surface and vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- E. Install sealants to depths recommended by the sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead:
 - 1. For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, but neither more than 5/8" deep nor less than 3/8" deep.
 - 2. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2" deep nor less than 1/4" deep.
 - 3. For joints sealed with non-elastomeric sealants and calking compounds, fill joints to a depth in the range of 75% to 125% of joint width.
 - 4. Spillage: Do not allow sealants or compounds to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces. Clean the adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.
 - 5. Do not overheat hot-applied sealants.
 - 6. Recess exposed edges of joint fillers slightly behind adjoining surfaces, so compressed units will not protrude from the joint.

3.3 CURE AND PROTECTION:

- A. Cure sealants and calking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Advise the Contractor of procedures required for the cure and protection of joint sealers during the construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at the time of acceptance.

3.4 SEALANT SCHEDULE

- A. Exterior Joints:
 - 1. Perimeters of exterior openings where frames and other penetrations meet exterior facade of building: precast concrete, brick, CMU, reinforced concrete.
 - a. Sealant Type - A2
 - b. Sealant Type - B1 (for prefinished materials only)
 - 2. Expansion and control joints in exterior surfaces of cast-in-place concrete walls, precast architectural wall panels.
 - a. Sealant Type - A2
 - b. Sealant Type - A4
 - c. Backer Material Type - F1
 - 3. Expansion and control joints in exterior surfaces of unit masonry walls.

- a. Sealant Type - A2
 4. Coping joints, coping-to-facade joints, cornice and wash, or horizontal surface joints not subject to foot or vehicular traffic.
 - a. Sealant Type - A2
 - b. Sealant Type - A4
 - c. Sealant Type - B1 (for prefinished materials only)
 5. Exterior joints in horizontal wearing and non-wearing surfaces.
 - a. Sealant Type - A1
 - b. Sealant Type - A3
 - c. Backer Material Type - F1
 6. Paving joints and curbs.
 - a. Sealant Type - A4
 - b. Sealant Type - P1 or P2
 7. Setting bed for threshold and saddles.
 - a. Sealant Type - E1
 8. Painted metal lap or flashing joints.
 - a. Sealant Type - B1
- B. Interior Joints:
1. Seal interior perimeters of exterior openings.
 2. Expansion and control joints on interior of exterior cast-in-place concrete walls.
 3. Expansion and control joints on interior of exterior surfaces of masonry walls.
 4. Perimeters of interior hollow metal and aluminum frames.
 5. Interior masonry vertical control joints and intersecting masonry walls; CMU-to-CMU, CMU-to-concrete.
 - a. For all of the above interior joints:
 - 1) Sealant Type - A2
 - 2) Sealant Type - A4
 - 3) Sealant Type - B1 (for prefinished materials only)
 6. Exposed interior control joints in drywall and concealed joints.
 - a. Sealant Type - C1
 - b. Sealant Type - D1
 7. Joints of underside of precast beams or planks.
 - a. Sealant Type - A2
 - b. Sealant Type - A4
 8. Joints at tops of non-load bearing masonry walls at underside of cast-in-place concrete.

- a. Sealant Type - A2
 - b. Sealant Type - A4
9. Perimeter of bath fixtures: sinks, urinals, water closets, basins, vanities, etc.
- a. Sealant Type - B4
10. Interior expansion and control joints in floor surfaces exposed to foot traffic.
- a. Sealant Type - A1
 - b. Sealant Type - A3
 - c. Backer Material Type - F1
11. Interior saw-cut contraction joints in exposed concrete floors exposed to heavy industrial type traffic.
- a. Sealant Type - P1
 - b. Sealant Type - P3
12. Interior non-moving joints, including control, contraction, or construction joints, in interior floor slabs exposed to heavy duty traffic.
- a. Sealant Type - P1
 - b. Sealant Type - P3
13. Painted metal lap joints.
- a. Sealant Type - B1
- C. Glazing:
- 1. Structural Glazing.
 - a. Sealant Type - B2
 - b. Sealant Type - B3
 - 2. General Purpose Glazing.
 - a. Sealant Type - B3
 - 3. End Damming.
 - a. Sealant Type - E1

END OF SECTION 07 90 00

SECTION 08 11 10 - METAL DOORS AND FRAMES

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: All steel door and frame work indicated on the drawings and herein specified, including cased opening, removable mullions, borrowed lites, transoms, access door and frames for cupola. etc.

1.3 RELATED WORK UNDER OTHER SECTIONS:

- A. Division 04 Sections for Masonry
- B. Division 05 Section - Cold Form Metal Framing
- C. Division 08 Section - Glass and Glazing.
- D. Division 08 Section - Builders' Hardware.
- E. Division 08 Section - Aluminum Doors and Frames.
- F. Division 09 Section – Non Structural Metal Framing

1.4 QUALITY ASSURANCE:

- A. Provide stock and indicated custom hollow metal work, which includes doors, door frames, frames for sidelights, transoms and other openings, and all related items, all manufactured by a single firm specializing in the production of this type of work.
- B. Provide stock doors and frames complying with the Steel Door Institute "Recommended Specifications for Standard Steel Doors and Frames" (ANSI/SDI 100, Latest Edition), except as herein specified.
 - 1. Manufacturers offering products to comply with the requirements for metal doors and frames include the following:
 - a. Steelcraft
 - b. Amweld Building Products
 - c. Ceco Corporation
 - d. Curries
 - e. Fenestra
 - f. Kewanee Corporation
 - g. Mesker Brothers Industries, Inc.
 - h. Pioneer Fireproof Door Co.
 - i. Republic Steel Corp.

C. Fire-Rated Assemblies:

1. Where a fire-resistance classification (3-hour, 1-1/2 hour, etc. or "A", "B", etc.) is shown or scheduled for hollow metal work, provide fire-rated hollow metal doors and frames investigated and tested as a fire door assembly, complete with type of fire door hardware to be used. Identify each fire door and frame with UL or FM labels, indicating applicable fire rating of both door and frame.
2. Provide assemblies to comply with NFPA Standard No. 80, and as herein specified.
3. Oversize Assemblies: Where hollow metal assemblies are larger than size limitations established by NFPA and UL and FM, provide manufacturer's certification that assembly has been constructed with materials and methods equivalent to labeled construction.

1.5 SUBMITTALS:

A. Product Data:

1. For information only, submit a copy of manufacturer's specifications for fabrication and shop-painting, and installation instructions.

B. Shop Drawings:

1. Submit shop drawings for the fabrication and erection of hollow metal work. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Provide fabrication, erection and anchorage details at 3" to 1'-0" scale. Show anchorage and accessory items.
2. Provide a schedule of doors and frames using same reference numbers for details and openings as those indicated.

C. Label Construction:

1. Submit manufacturer's certification for oversize fire-rated doors and frames that each assembly has been constructed with materials and methods equivalent to requirements for labeled construction.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver hollow metal work cartoned or crated to provide protection during transit and job storage.
- B. Inspect hollow metal work upon delivery for damage. Minor damages may be repaired provided the finish items are equal in all respects to new work and acceptable to the Architect; otherwise, remove and replace damaged items as directed.
- C. Store doors and frames at the building site under cover. Place units on at least 4" high wood sills or on floors in a manner that will prevent rust and damage. Avoid the use of non-vented plastic or canvas shelters which could create a humidity chamber. If the cardboard wrapper on the door becomes wet, remove the carton immediately. Provide a 1/4" space between stacked doors to promote air circulation.

1.7 JOB CONDITIONS:

- A. Examine the substrate and conditions under which hollow metal work is to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.

PART 2 - PRODUCTS

A. MATERIALS:

1. Hot-Rolled Steel Sheets and Strip:
 - a. Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM A 568.
2. Cold-Rolled Steel Sheets:
 - a. Commercial quality carbon steel, complying with ASTM A 366 and ASTM A 568.
3. Galvanized Steel Sheets:
 - a. Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526 or A 642; with A60 (0.60 oz. per sf) oz. commercial zinc coating, mill phosphatized, complying with ASTM A 525.
4. Supports and Anchors:
 - a. Fabricate of not less than 16 gauge sheet steel. Galvanize after fabrication, units to be built into exterior walls, complying with ASTM A 153, Class B.
5. Inserts, Bolts and Fasteners:
 - a. Manufacturer's standard units, except hot-dip galvanize items to be built into exterior walls, complying with ASTM A 153, Class C or D as applicable.
6. Shop-Applied Paint:
 - a. For steel surfaces, use rust-inhibitive enamel or paint, either air-drying or baking, medium gray color, suitable as a base for specified finish paints.
 - b. Paint galvanized surfaces with gray zinc dust-zinc oxide primer.

2.2 FABRICATION, GENERAL:

- A. Fabricate hollow metal units to be rigid, neat in appearance and free from defects, warp or buckle. Accurately form metal to required sizes and profiles. Where practical, fit and assemble units in the manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment to assure proper assembly at the project site. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible. Metallic filler to conceal manufacturing defects is not acceptable.
- B. Provide all hollow metal doors and frames receiving electromechanical hardware with wiring harness and Molex™ standardized concealed plug connectors to accommodate up to twelve (12) wires. Coordinate Molex™ connectors on end of the wiring harness to plug directly into the electrified hardware and the electric hinge.
- C. Exposed Fasteners:
 1. Provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.
- D. Finish Hardware Preparation:
 1. Drill frames for door silencers and insert plastic construction plugs.
 2. Prepare hollow metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with final Finish Hardware Schedule and templates provided under Section 08700. Comply with applicable requirements of ANSI A115 "Specifications for Door and Frame Preparation".
 3. Reinforce hollow metal units to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.
 4. Locate finish hardware in accordance with "Recommended Locations for Builders' Hardware", published by the National Builders' Hardware Association.

5. Doors and Frames: Provide doors and frames at access controlled openings with concealed wiring harnesses and electrical connectors to properly receive the specified electromechanical hardware.

E. Shop Painting:

1. Clean, treat and paint surfaces of fabricated hollow metal units, including galvanized surfaces, whether concealed or exposed in the finished work.
2. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before the application of the shop coat of paint.
3. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC-PT2), hot phosphate solution (SSPC-PT4) or basic zinc chromate-vinyl butyral solution (SSPC-PT3).
4. Prime finish: Doors and frames shall be thoroughly cleaned, and chemically treated to insure maximum paint adhesion. All surfaces of the door and frame exposed to view shall receive a factory applied coat of rust inhibiting primer, either air-dried or baked-on. The finish shall meet the requirements for acceptance stated in ANSI/SDI A250.10 "Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames."

2.3 DOORS:

A. Provide Grade I, Model 1, full flush hollow steel construction.

1. Provide sound insulation filler of fiberboard, mineral-wool board, or manufacturer's standard insulation, solidly packed full door height to fill the voids between inner core reinforcing members.
2. For single-acting swing doors, bevel both vertical edges 1/8" in 2". For double-acting swing doors, round vertical edges with a 2-1/8" radius.
3. Astragals: 12 gauge x 1-1/2" wide steel, welded to full height of door, on active leaf.
4. Reinforce doors with rigid tubular frame where stiles and rails are less than 8" wide. Form tubular frame with 16 gage steel, welded to outer sheets.

B. Exterior Doors:

1. Fabricate exterior doors of two outer galvanized, stretcher-leveled steel sheets not less than 16 gage. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges, except around glazed or louvered panel inserts.
2. Reinforce inside of doors with vertical galvanized sheet steel channel-shaped sections or interlocking Z-shaped sections not less than 20 gage. Space vertical reinforcing 6" o.c. and extend full door height. Spot-weld at 4" o.c. to both outer sheets.
 - a. Continuous truss-form inner core of 28 gage galvanized sheet steel reinforcing may be provided as inner reinforcement, in lieu of above. Spot-weld truss-form reinforcement 3" o.c. vertically and horizontally over entire surface of both sides.
3. Reinforce tops and bottoms of doors with 16 gage galvanized horizontal steel channels welded continuously to the outer sheets. Close top and bottom edges to provide weather seal, as integral part of door construction or by addition of inverted steel channels.
4. Insulated doors are to be completely filled with a rigid polyurethane core chemically bonded to all interior surfaces with a minimum insulation u-value of 0.11 (R 9) as tested on an operable door.

C. Interior Doors:

1. Fabricate interior doors of two outer cold-rolled, stretcher-leveled steel sheets not less than 18 gage. Construct doors with smooth, flush surfaces, without visible joints or seams on exposed faces or stile edges, except around glazed or louvered panel inserts.

2. Reinforce inside of doors with vertical, hot-rolled, 20 gage steel channel-shaped sections or interlocking Z-shaped steel sections. Space vertical reinforcing 6" o.c. and extend full door height. Spot weld at 4" o.c. to both outer sheets.
 - a. Continuous truss-form inner core of 28 gage sheet metal reinforcing may be provided as inner reinforcement in lieu of above. Spot-weld truss-form reinforcement 3" o.c. vertically and horizontally over entire surface of both sides.
 3. Reinforce tops and bottoms of doors with 18 gage, horizontal steel channels, welded continuously to the outer sheets.
- D. Interior Doors, indicated to be galvanized:
1. Fabricate interior doors of two outer galvanized cold-rolled, stretcher-leveled steel sheets not less than 18 gage. Construct doors with smooth, flush surfaces, without visible joints or seams on exposed faces or stile edges, except around glazed or louvered panel inserts.
 2. Reinforce inside of doors with vertical galvanized 20 gage galvanized steel channel-shaped sections or interlocking Z-shaped steel sections. Space vertical reinforcing 6" o.c. and extend full door height. Spot weld at 4" o.c. to both outer sheets.
 - a. Continuous truss-form inner core of 28 gage sheet metal reinforcing may be provided as inner reinforcement in lieu of above. Spot-weld truss-form reinforcement 3" o.c. vertically and horizontally over entire surface of both sides.
 3. Reinforce tops and bottoms of doors with 18 gage, galvanized horizontal steel channels, welded continuously to the outer sheets.
- E. Finish Hardware Reinforcement:
1. Reinforce doors for required finish hardware, as follows:
 - a. Hinges: Steel plate 3/16" thick x 1-1/2" wide x 6" longer than hinge, secured by not less than 6 spot-welds.
 - b. Mortise locksets and dead bolts: 14 gage steel sheet, secured with not less than two spot-welds.
 - c. Cylinder Locks: 14 gage steel sheet, secured with not less than two spot-welds.
 - d. Flush Bolts: 14 gage steel sheet, secured with not less than two spot-welds.
 - e. Surface-Applied Closers: 12 gage steel sheet, secured with not less than six spot-welds.
 - f. Push Plates and Bars: 16 gage steel sheet, (except when through bolts are shown or specified), secured with not less than two spot-welds.
 - g. Surface Panic Devices: 14 gage sheet steel (except when through bolts are shown or specified), secured with not less than two spot-welds.
 - h. Automatic Door Bottoms: Reinforce for mortise-type units with 12 gage steel, and 16 gage for surface-applied units.
 2. Galvanize reinforcing at doors required to be galvanized.
- 2.4 FRAMES:
- A. Fabricate frames of full-welded unit construction, with corners mitered, reinforced, continuously welded full depth and width of frame.
 1. Knock-down type frames are not acceptable.
 - B. Form frames of galvanized steel sheets for exterior, and either cold or hot-rolled sheet steel for interior. Provide galvanized frames at interior doors required to be galvanized.
 1. Gage: Not less than 14, for exterior openings up to 4'-0" wide.
 2. Gage: Not less than 16, for interior openings up to 4'-0" wide.
 3. For openings over 4'-0" wide, increase thickness by at least two standard gages.

- C. Finish Hardware Reinforcement:
1. Reinforce frames for required finish hardware, as follows:
 - a. Hinges: Steel plate 3/16" thick x 1-1/2" wide x 6" longer than hinge, secured by not less than six spot-welds.
 - b. Strike Plate Clips: Steel plate 3/16" thick x 1-1/2" wide x 3" long.
 - c. Surface-Applied Closers: 12 gage steel sheet, secured with not less than six spot-welds.
 2. Galvanize reinforcing at doors required to be galvanized.
- D. Mullions and Transom Bars:
1. Provide closed or tubular mullions and transom bars, where indicated. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between frame members with concealed clip angles or sleeves same metal and thickness as frame.
 2. Provide removable mullions, where indicated. Weld a bottom closure piece within the mullion, so that insulation fill (provided under Division 7) will remain contained.
 3. Where installed in masonry, leave vertical mullions in frame open at the top so they can be filled with grout.
- E. Jamb Anchors:
1. Furnish jamb anchors as required to secure frames to adjacent construction, formed of not less than 18 gage galvanized steel.
 - a. Masonry Construction: Adjustable, flat or corrugated or perforated, shaped to suit frame size with leg not less than 2" wide by 10" long. Furnish at least 3 anchors per jamb up to 7'-6" height; 4 anchors up to 8'-0" jamb height; one additional anchor for each 24" or fraction thereof over 8'-0" height.
 - b. Metal Stud Partitions: Insert type with notched clip to engage metal stud, welded to back of frames. Provide at least 4 anchors for each jamb for frames up to 7'-6" in height; 5 anchors up to 8'-0" jamb height; one additional anchor for each 24" or fraction thereof over 8'-0" height.
 - c. In-place Concrete or Masonry: Anchor frame jambs with minimum 3/8" concealed bolts into expansion shields or inserts at 6" from top and bottom and 26" o.c., unless otherwise shown. Reinforce frames at anchor locations. Apply removable stop to cover anchor bolts.
- F. Floor Anchors:
1. Provide floor anchors for each jamb and mullion which extends to floor, formed of not less than 16 gage galvanized steel sheet, as follows:
 - a. Monolithic Concrete Slabs: Clip type anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions.
 - b. Separate Topping Concrete Slabs: Adjustable type with extension clips. Terminate bottom of frames at finish floor surface.
- G. Head Anchors:
1. Provide two anchors at head of frames exceeding 42" wide for frames mounted in steel stud walls.
- H. Head Strut Supports:
1. Provide 3/8" x 2" vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to construction at

each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.

I. Structural Reinforcing Members:

1. Provide structural reinforcing members as a part of frame assembly, at mullions, transoms, or other locations which are to be built into frame.

J. Head Reinforcing:

1. For frames over 4'-0" wide provide two continuous steel angles not less than 2" x 2" x 12 gage and width of opening, welded to back of frame at head.

K. Spreader Bars:

1. Provide two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

L. Rubber Door Silencers:

1. Drill stops to receive three silencers on single-door frames and two silencers on double-door frames. Install plastic plugs to keep holes clear during construction.

M. Frame Guards:

1. Provide 26 gage guards or mortar boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation.

2.5 LOUVERS:

- A. Fabricate louvers and mount flush into doors without overlapping moldings on surface of door-facing sheets. Provide internal support as recommended by louver manufacturer.
- B. Interior Louvers: Sightproof, stationary type, constructed of inverted Y-shaped blades formed of 18 gage cold-rolled steel. Space blades not more than 3" o.c. to provide not less than 55% free air opening.

2.6 STOPS AND MOLDINGS:

- A. Provide stops and moldings around glazed panels in hollow metal units and in frames to receive door.
- B. Form fixed stops and moldings integral with frame. Provide removable stops on inside of hollow metal units exposed to exterior and on corridor side of interior units.
- C. Provide removable stops and molds at other locations, formed of not less than 20 gage steel sheets, exterior, galvanized and interior cold-rolled. Secure with machine screws spaced uniformly not more than 12" o.c. Form corners with butted hairline joints.
- D. Coordinate width of rabbet between fixed and removable stops with type of glass or panel and type of installation indicated.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install hollow metal units and accessories in accordance with the final shop drawings, manufacturer's data, and as herein specified.
- B. Setting Masonry Anchorage Devices:

1. Provide masonry anchorage devices for securing hollow metal frames to in-place concrete or masonry construction.
2. Set anchorage devices opposite each anchor location, in accordance with details and anchorage device manufacturer's instructions. Leave drilled holes rough, not reamed, and free from dust and debris.
3. Floor anchors may be set with powder-actuated fasteners instead of masonry anchorage devices and machine screws, if so indicated.

C. Placing Frames:

1. Set frames accurately in position, plumbed, aligned and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving smooth and undamaged.
 - a. In masonry construction, building-in of anchors and grouting of frames is included in Division 4 of these specifications.
 - b. At in-place concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.
 - c. Place fire-rated frames in accordance with NFPA Standard No. 80.
 - d. Make field splices in frames welded and finished to match factory work.
 - e. Remove spreader bars only after frames or bucks have been properly set and secured.

D. Door Installation:

1. Fit hollow metal doors accurately in their respective frames, within the following clearances:
 - a. Jambs and Head: 3/32".
 - b. Meeting Edges, Pairs of Doors: 1/8".
 - c. Bottom: 3/8", where no threshold or carpet.
 - d. Bottom, at threshold or carpet: 1/8".
2. Place fire-rated doors with clearances as specified in NFPA Standard No. 80.

3.2 ADJUST AND CLEAN:

A. Final Adjustments:

- B. Check and readjust operating finish hardware items in hollow metal work just prior to final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames which are warped, bowed or otherwise damaged.

C. Prime Coat Touch-Up:

1. Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer. Continue this procedure throughout the construction process, so that no rusted or damage conditions exist prior to the finish painting specified in Division 9.

END OF SECTION 08 10 00

1 SECTION 08 21 10 - FLUSH WOOD DOORS

2 PART 1 - GENERAL

3 1.1 RELATED DOCUMENTS

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

6 1.2 SUMMARY

7 A. Section Includes:

- 8 1. Solid-core doors with wood-veneer faces.
-
- 9 2. Factory finishing flush wood doors.
-
- 10 3. Factory fitting flush wood doors to frames and factory machining for hardware.

11 B. Related Sections:

- 12 1. Division 01 Section "Sustainable Design Requirements" for additional LEED
-
- 13 requirements.
-
- 14 2. Division 06 Section "Interior Architectural Woodwork" for requirements for veneers from
-
- 15 the same flitches for both flush wood doors and wood paneling.
-
- 16 3. Division 08 Section "Glazing" for glass view panels in flush wood doors.
-
- 17 4. Division 08 Section "Hollow Metal Doors & Frames".

18 1.3 SUBMITTALS

- 19 A. Product Data: For each type of door indicated. Include details of core and edge construction
-
- 20 and trim for openings. Include factory-finishing specifications.

- 21 B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door;
-
- 22 construction details not covered in Product Data; location and extent of hardware blocking; and
-
- 23 other pertinent data.

- 24 1. Indicate dimensions and locations of mortises and holes for hardware.
-
- 25 2. Indicate dimensions and locations of cutouts.
-
- 26 3. Indicate requirements for veneer matching.
-
- 27 4. Indicate doors to be factory finished and finish requirements.
-
- 28 5. Indicate fire-protection ratings for fire-rated doors.

- 29 C. Samples for Initial Selection: For factory-finished doors.

30 D. Samples for Verification:

- 31 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for
-
- 32 each material and finish. For each wood species and transparent finish, provide set of
-
- 33 three samples showing typical range of color and grain to be expected in the finished
-
- 34 work.

- 1 2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges
2 representing actual materials to be used.
- 3 a. Provide samples for each species of veneer and solid lumber required.
4 b. Provide samples for each color, texture, and pattern of plastic laminate required.
5 c. Finish veneer-faced door samples with same materials proposed for factory-
6 finished doors.
- 7 3. Frames for light openings, 6 inches long, for each material, type, and finish required.
- 8 E. Warranty: Sample of special warranty.
- 9 1.4 QUALITY ASSURANCE
- 10 A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an
11 FSC-accredited certification body.
- 12 B. Source Limitations: Obtain flush wood doors from single manufacturer.
- 13 C. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural
14 Woodwork Quality Standards Illustrated.", WDMA I.S.1-A, "Architectural Wood Flush Doors."
15 and WI's "Manual of Millwork."
- 16 1. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating
17 that doors comply with requirements of grades specified.
18 2. Provide WI-Certified Compliance Certificate indicating that doors comply with
19 requirements of grades specified.
20 3. Provide WI-Certified Compliance Certificate for installation.
- 21 D. Forest Certification: Provide doors made with not less than 70 percent of wood products
22 obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-
23 01-001, "FSC Principles and Criteria for Forest Stewardship."
- 24 E. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a
25 qualified testing agency, for fire-protection ratings indicated, based on testing at positive
26 pressure according to NFPA 252 or UL 10B.
- 27 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies,
28 provide certification by a qualified testing agency that doors comply with standard
29 construction requirements for tested and labeled fire-rated door assemblies except for
30 size.
- 31 F. LEED Submittals:
- 32 1. As indicated in previous Sections of the Project Manual, this project is pursuing LEED
33 Silver certification from the U.S. Green Building Council (USGBC). The contractor will be
34 required to provide certification to the architect that materials under in this section
35 conform to the requirements for LEED MR Credit 7, EQ Credit 4.2, and EQ Credit 4.4.
36 Refer to section 018113 for additional LEED requirements regarding this section.
- 37 1.5 DELIVERY, STORAGE, AND HANDLING
- 38 A. Comply with requirements of referenced standard and manufacturer's written instructions.

- 1 B. Package doors individually in plastic bags or cardboard cartons.
- 2 C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

3 1.6 PROJECT CONDITIONS

- 4 A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and
5 weathertight, wet work in spaces is complete and dry, and HVAC system is operating and
6 maintaining ambient temperature and humidity conditions at occupancy levels during the
7 remainder of the construction period.

8 1.7 WARRANTY

- 9 A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or
10 replace doors that fail in materials or workmanship within specified warranty period.

- 11 1. Failures include, but are not limited to, the following:
- 12 a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
- 13 b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch
14 span.
- 15 2. Warranty shall also include installation and finishing that may be required due to repair or
16 replacement of defective doors.
- 17 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

18 PART 2 - PRODUCTS

19 2.1 MANUFACTURERS

- 20 A. Manufacturers: Subject to compliance with requirements, provide products by one of the
21 following:
- 22 1. Algoma Hardwoods, Inc.
- 23 2. Chappell Door Co.
- 24 3. Eggers Industries.
- 25 4. Graham
- 26 5. Lambton Doors.
- 27 6. Marshfield Door Systems, Inc.
- 28 7. Mohawk Flush Doors, Inc.; a Masonite company.
- 29 8. Oshkosh Architectural Door Company.
- 30 9. Vancouver Door Company.
- 31 10. VT Industries Inc.

32 2.2 DOOR CONSTRUCTION, GENERAL

- 33 A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that
34 do not contain urea formaldehyde.
- 35 B. WDMA I.S.1-A Performance Grade: Heavy Duty.

- 1 C. Provide all wood doors receiving electromechanical hardware with wiring harness and
2 Molex™ standardized concealed plug connectors to accommodate up to twelve (12) wires.
3 Coordinate Molex™ connectors on end of the wiring harness to plug directly into the electrified
4 hardware and the electric hinge.
- 5 D. Particleboard-Core Doors:
- 6 1. Particleboard: ANSI A208.1, Grade LD-2.
7 2. Blocking: Provide wood blocking in particleboard-core doors as follows:
- 8 a. 5-inch top-rail blocking, in doors indicated to have closers.
9 b. 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick,
10 mop, or armor plates.
11 c. 5-inch midrail blocking, in doors indicated to have exit devices.
- 12 3. Provide doors with either glued-wood-stave or structural-composite-lumber cores instead
13 of particleboard cores for doors indicated to receive exit devices.
- 14 E. Structural-Composite-Lumber-Core Doors:
- 15 1. Structural Composite Lumber: WDMA I.S.10.
16 a. Screw Withdrawal, Face: 700 lbf.
17 b. Screw Withdrawal, Edge: 400 lbf.
- 18 F. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-
19 protection rating indicated.
- 20 1. Edge Construction: Provide edge construction with intumescent seals concealed by
21 outer stile. Comply with specified requirements for exposed edges.
22 2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated
23 without formed-steel edges and astragals. Provide stiles with concealed intumescent
24 seals. Comply with specified requirements for exposed edges.
- 25 G. Mineral-Core Doors:
- 26 1. Core: Noncombustible mineral product complying with requirements of referenced
27 quality standard and testing and inspecting agency for fire-protection rating indicated.
28 2. Blocking: Provide composite blocking with improved screw-holding capability approved
29 for use in doors of fire-protection ratings indicated as follows:
- 30 a. 5-inch top-rail blocking.
31 b. 5-inch bottom-rail blocking, in doors indicated to have protection plates.
32 c. 5-inch midrail blocking, in doors indicated to have armor plates.
33 d. 5-inch midrail blocking, in doors indicated to have exit devices.
- 34 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved
35 screw-holding capability and split resistance. Comply with specified requirements for
36 exposed edges.

- 1 2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH
- 2 A. Interior Solid-Core Doors
- 3 1. Grade: Premium, with Grade AA faces.
- 4 2. Species: As indicated on drawings. If not indicated on drawings, provide Red Oak.
- 5 3. Cut: Plain sliced (flat sliced).
- 6 4. Match between Veneer Leaves: Book match.
- 7 5. Assembly of Veneer Leaves on Door Faces: Balance match.
- 8 6. Pair and Set Match: Provide for doors hung in same opening or separated only by
- 9 mullions.
- 10 7. Room Match: Match door faces within each separate room or area of building. Corridor-
- 11 door faces do not need to match where they are separated by 20 feet or more.
- 12 8. Room Match: Provide door faces of compatible color and grain within each separate
- 13 room or area of building.
- 14 9. Core: Particleboard, Glued wood stave, or Structural composite lumber.
- 15 10. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive
- 16 planed before veneering. Faces are bonded to core using a hot press.
- 17 11. WDMA I.S.1-A Performance Grade: Heavy Duty.
- 18 2.4 LIGHT FRAMES
- 19 A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads
- 20 as follows unless otherwise indicated.
- 21 1. Wood Species: Same species as door faces.
- 22 2. Profile: Manufacturer's standard shape.
- 23 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal
- 24 glazing clips approved for such use.
- 25 B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-
- 26 veneered noncombustible beads matching veneer species of door faces and approved for use
- 27 in doors of fire-protection rating indicated. Include concealed metal glazing clips where required
- 28 for opening size and fire-protection rating indicated.
- 29 2.5 FABRICATION
- 30 A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of
- 31 referenced quality standard for fitting unless otherwise indicated.
- 32 1. Comply with requirements in NFPA 80 for fire-rated doors.
- 33 B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply
- 34 with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings,
- 35 DHI A115-W series standards, and hardware templates.
- 36 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment
- 37 before factory machining.
- 38 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for
- 39 pairs of fire-rated doors.
- 40 3. Provide doors and frames at access controlled openings with concealed wiring harnesses
- 41 and electrical connectors to properly receive the specified electromechanical hardware.

- 1 C. Openings: Cut and trim openings through doors in factory.
- 2 1. Light Openings: Trim openings with moldings of material and profile indicated.
- 3 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with
- 4 applicable requirements in Division 08 Section "Glazing."
- 5 2.6 FACTORY FINISHING
- 6 A. General: Comply with referenced quality standard for factory finishing. Complete fabrication,
- 7 including fitting doors for openings and machining for hardware that is not surface applied,
- 8 before finishing.
- 9 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be
- 10 omitted on bottom edges, edges of cutouts, and mortises.
- 11 B. Finish doors at factory.
- 12 C. Transparent Finish:
- 13 1. Grade: Premium.
- 14 2. Finish: AWI TR-4 conversion varnish system.
- 15 3. Staining: As selected by Architect from manufacturer's full range.
- 16 4. Effect: Filled finish.
- 17 5. Sheen: Satin.

18 PART 3 - EXECUTION

19 3.1 EXAMINATION

- 20 A. Examine doors and installed door frames before hanging doors.
- 21 1. Verify that frames comply with indicated requirements for type, size, location, and swing
- 22 characteristics and have been installed with level heads and plumb jambs.
- 23 2. Reject doors with defects.
- 24 B. Proceed with installation only after unsatisfactory conditions have been corrected.

25 3.2 INSTALLATION

- 26 A. Hardware: For installation, see Division 08 Section "Door Hardware."
- 27 B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the
- 28 referenced quality standard, and as indicated.
- 29 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
- 30 C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- 31 D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at
- 32 Project site.

- 1 3.3 ADJUSTING
- 2 A. Operation: Rehang or replace doors that do not swing or operate freely.
- 3 B. Finished Doors: Replace doors that are damaged or that do not comply with requirements.
- 4 Doors may be repaired or refinished if work complies with requirements and shows no evidence
- 5 of repair or refinishing.

- 6 END OF SECTION 08 14 16

SECTION 08 43 10 - ALUMINUM STOREFRONT WINDOWS

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. The extent of each type (operation and size) of aluminum window unit is shown.

- B. The applications of aluminum windows on the project include:

- 1. Units set in masonry work and/or stud work as indicated on drawings.

- C. Design Criteria for this Project: Wind load, deflection and pressures in accordance with the governing Building Code or the ANSI Standard A58.1 "Components and Cladding", whichever is most stringent.

1.3 RELATED WORK:

- A. Division 07 Section "Flashing and Sheet Metal".
- B. Division 07 Section "Insulation".
- C. Division 07 Section "Joint Sealers".
- D. Division 07 Section "Air and Vapor Barrier".
- E. Division 08 Section "Glass and Glazing".

1.4 QUALITY ASSURANCE:

- A. Standards: The requirements for aluminum windows, and the terminology and standards of performance and fabrication workmanship, are those specified and recommended in ANSI/AAMA 101-93 and the applicable general recommendations published by NAAMM and AA.

1.5 SUBMITTALS:

- A. Product data for each type of window required, including:
 - 1. Construction details and fabrication methods.
 - 2. Profiles and dimensions of individual components.

3. Data on hardware, accessories, and finishes.
 4. Recommendations for maintenance and cleaning of exterior surfaces.
- B. Shop drawings for each type of window required. Include information not fully detailed in manufacturer's standard product data and the following:
1. Layout and installation details, including anchors, complete with windload calculations and structural fastening calculations, stamped and sealed by a professional engineer licensed in the State of the project location.
 2. Elevations at 1/4-inch = 1 foot scale, and typical window unit elevations at 3/4-inch = 1 foot scale.
 3. Full-size section details of typical composite members, including reinforcement and stiffeners.
 4. Location of weep holes.
 5. Panning details
 6. Hardware, including operators.
 7. Glazing details.
 8. Accessories.
- C. Test reports from a qualified independent testing agency indicating that each type, grade, and size of window unit complies with each performance requirement indicated. Test results based on use of down-sized test units will not be accepted.
1. Manufacturer's certification of compliance with requirements of the AAMA standards for poured-and-debrided thermal breaks included in Quality Assurance article of this Section.
- D. Manufacturer: Provide aluminum units produced by a single firm, capable of showing prior successful production of units similar to those required.
- E. Performance and Testing: Comply with the air infiltration tests, water resistance tests and applicable load tests specified in ANSI/AAMA 101-93 for the type and classification of window unit required in each case.
- F. Labelling: Provide labels, on each window unit, indicating AAMA or window classification grade conformance to these specifications.
- G. Testing: Where manufacturer's standard window units comply with the requirements and have been tested in accordance with the specified tests, provide certification by the manufacturer of compliance with such tests; otherwise, perform the required tests through a recognized testing laboratory or agency and provide certified test results.
- H. Manufacturer's Data: For information only, submit copies of manufacturer's specifications, recommendations and standard details for aluminum window units, including fabrication, finishing, hardware and other components of the work. Include certified test laboratory reports as necessary to show compliance with the requirements.
- I. Samples: Submit samples of each required aluminum finish, on 24" long sections of extrusion shapes as required for the window units. Where color or texture of finish will vary slightly for the work, include 2 or more sections in each sample, to show the limits of such variations. Samples will be reviewed for color and texture only. Compliance with other requirements is the exclusive responsibility of the Contractor.

1. Architect reserves the right to require samples which will show the fabrication techniques and workmanship of component parts, and the design of hardware and other exposed auxiliary items for window units, before fabrication of the work.
- J. Affidavit: Submit copies of manufacturer's current (within six months of installation) affidavit indicating conformance to the performance specification herein designated, as well as current testing laboratory certification.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

- A. Kawneer #VG451T Framing System, for "fixed windows".

2.2 MATERIALS:

- A. Aluminum Extrusions: Alloy and temper recommended by window manufacturer for strength, corrosion resistance and application of required finish, but not less than 22,000 psi ultimate tensile strength and not less than 0.062" thickness at any location for main frame and sash members.
- B. Fasteners: Aluminum or stainless steel compatible with the aluminum window members, trim, hardware, anchors and other components of the window units.
 1. Do not use exposed fasteners except where unavoidable for the application of hardware. Match the finish of the metal surrounding the fastener.
 2. Provide Phillips flat-head machine screws for exposed fasteners.
- C. Sealant: Provide type recommended by window manufacturer for the joint size and movement, to remain permanently elastic, non-shrinking and non-migrating. See Division 7 for installation of sealants.
- D. Glass and Glazing Materials: Sections 088000 and 088853.
- E. Muntins: Kawneer #735-005 Applied Muntins, 3/4" x 5/16".

2.3 FIXED WINDOWS:

- A. General: The following paragraphs define the operating arrangement for required types of sash (ventilators) in window units, and specify minimum provisions for each type. Provide non-bullet resistant window framing profiles to match bullet resistant framing profiles specified in Section 130650.
- B. Fixed Aluminum Windows: Except for special provisions as indicated for maintenance, cleaning and removal, no operating hardware or equipment is required.
 1. Thermo-Break Type: Construct entire unit, with locked-in plastic or rubber thermo-breakers, so that none of the aluminum exposed to the exterior has metal to metal contact with the aluminum exposed on the interior.

2.4 WINDOW CLASSIFICATION (GRADE):

- A. General: The aforementioned classification(s) are related to the requirements of the AAMA/NWWDA Classification System, and AAMA/NWWDA 101 except to the extent more stringent requirements are specified.
 - 1. Grade HC: For "Heavy Commercial" buildings.

2.5 FABRICATION AND ACCESSORIES:

- A. General: Provide manufacturer's standard fabrication and accessories, except where more specific or more stringent requirements are indicated and specified. Include complete system for assembly of components and anchorage of window units, and prepare sash for glazing.
- B. Sizes and Profiles: The required sizes for window units and the profile requirements, to match Section 130650, are shown. Variable dimensions (if any) are indicated along with maximum and minimum dimensions as required to achieve design requirements and coordination with other work.
 - 1. The details shown are based upon standard details by Kawneer. It is intended that similar details by other manufacturers will be acceptable, provided they comply with the size requirements, and with minimum/maximum profile requirements as shown.
- C. Types and Classifications: The drawings indicate the required aluminum window types (defined to mean the manner of operation), whether for ventilation or for glass cleaning or other purposes. Except as otherwise shown, provide the classification or grade (quality and weight) specified herein.
- D. Coordination of Fabrication: Where possible, check actual window openings in the construction work by accurate field measurement before fabrication, and show recorded measurements on final shop drawings. However, coordinate fabrication schedule with construction progress as directed by Contractor to avoid delay of the work. Where necessary, proceed with fabrication without field measurements, and coordinate installation tolerances to ensure proper fit of window units.
- E. Provide subframes for window units where shown, of the profile and dimensions indicated but not less than 0.062" thickness extruded aluminum; with mitered or coped corners, welded and dressed smooth or with concealed mechanical joint fasteners; with anchors; finish to match window units.
- F. Provide mullions and cover plates as shown, matching window units, and complete with anchors for support to structure and for installation of window units. Allow for erection tolerances and provide for movements of window units due to thermal expansion and building deflections, in the manner indicated.

2.6 ALUMINUM WINDOW FINISHES:

- A. Natural Anodized Finish: NAAMM AA-C22A41, Class I (minimum thickness of 0.7 mils), natural aluminum color.

2.7 PREGLAZED FABRICATION:

- A. It is required that the window units, wherever installation requirements will permit, be glazed in the shop, prior to installation. However, Contractor, at his option, may elect to glaze the units after installation to facilitate the overall project construction requirements. See 088000 and 088853 sections for glass and glazing requirements.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Comply with manufacturer's specifications and recommendations for the installation of window units, hardware, operators, and other components of the work.
 - 1. Muntins: Provide muntins, at windows, as indicated on drawings.
 - 2. Do not install window until after wall opening has been properly and completely flashed at head, jamb and sill by other trades.
- B. Set units plumb, level and true to line, without warp or rack of frames or sash. Anchor securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
- C. Set sill members and other members in a bed of compound as shown, or with joint fillers or gaskets as shown to provide weathertight construction. Refer to Division 7 for compounds, fillers and gaskets to be installed concurrently with window units.
 - 1. Compounds, joint fillers and gaskets (if any) to be installed after the installation of window units are specified in the Division 7.
 - a. Install low-expansion polyurethane foam insulation around frame, concealed from view.
- D. Clean aluminum surfaces promptly after installation of windows, exercising care to avoid damage of the protective coating (if any). Remove excess glazing and sealant compounds, dirt and other substances. Lubricate hardware and other moving parts. Remove labels only after each window unit has been reviewed and accepted.
- E. Advise Contractor of protective treatment and other precautions required through the remainder of the construction period, to ensure that window units will be without damage or deterioration (other than normal weathering) at the time of acceptance.

END OF SECTION 08 43 10

SECTION 087100 – DOOR HARDWARE

GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY

This Section includes commercial door hardware for the following:

- Swinging doors.
- Sliding doors.
- Other doors to the extent indicated.

Door hardware includes, but is not necessarily limited to, the following:

- Mechanical door hardware.
- Electromechanical door hardware, power supplies, back-ups and surge protection.
- Cylinders specified for doors in other sections.

Related Sections:

- Division 08 Section "Door Hardware Schedule".
- Division 08 Section "Hollow Metal Doors and Frames".
- Division 08 Section "Interior Aluminum Doors and Frames".
- Division 08 Section "Flush Wood Doors".
- Division 08 Section "Access Control Hardware".

Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

- ANSI A117.1 - Accessible and Usable Buildings and Facilities.
- ICC/IBC - International Building Code.
- NFPA 80 - Fire Doors and Windows.
- NFPA 101 - Life Safety Code.
- NFPA 105 - Installation of Smoke Door Assemblies.
- State Building Codes, Local Amendments.

Standards: All hardware specified herein shall comply with the following industry standards:

- ANSI/BHMA Certified Product Standards - A156 Series
- UL10C – Positive Pressure Fire Tests of Door Assemblies

SUBMITTALS

Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

Content: Include the following information:

- Type, style, function, size, label, hand, and finish of each door hardware item.
- Manufacturer of each item.
- Fastenings and other pertinent information.
- Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
- Explanation of abbreviations, symbols, and codes contained in schedule.
- Mounting locations for door hardware.
- Door and frame sizes and materials.

Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

Shop Drawings: Details of electrified access control hardware indicating the following:

Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
- Complete (risers, point-to-point) access control system block wiring diagrams.

Electrical Coordination: Coordinate with related Division 26 Electrical Sections the voltages and wiring details required at electrically controlled and operated hardware openings.

Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.

Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final

copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.

Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

QUALITY ASSURANCE

Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum 3 years documented experience installing both standard and electrified builders hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor in good standing by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

Scheduling Responsibility: Preparation of door hardware and keying schedules.

Source Limitations: Obtain each type and variety of Door Hardware specified in this Section from a single source, qualified supplier unless otherwise indicated.

Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:

NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:

Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.

Door Closers: Comply with the following maximum opening-force requirements indicated:

Interior Hinged Doors: 5 lbf applied perpendicular to door.
Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.

NFPA 101: Comply with the following for means of egress doors:

Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.

Thresholds: Not more than 1/2 inch high.

Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 (neutral pressure at 40" above sill) or UL-10C.

Test Pressure: Positive pressure labeling.

Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

- Function of building, purpose of each area and degree of security required.
- Plans for existing and future key system expansion.
- Requirements for key control storage and software.
- Installation of permanent keys, cylinder cores and software.
- Address and requirements for delivery of keys.

Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.

Review sequence of operation narratives for each unique access controlled opening.

Review and finalize construction schedule and verify availability of materials.

Review the required inspecting, testing, commissioning, and demonstration procedures

At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

DELIVERY, STORAGE, AND HANDLING

Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

COORDINATION

Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

WARRANTY

General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

Structural failures including excessive deflection, cracking, or breakage.

Faulty operation of the hardware.

Deterioration of metals, metal finishes, and other materials beyond normal weathering.

Electrical component defects and failures within the systems operation.

Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

Special Warranty Periods:

Ten years for mortise locks and latches.

Five years for exit hardware.

Twenty five years for manual surface door closers.
Two years for electromechanical door hardware.

MAINTENANCE SERVICE

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.

Continuing Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

PRODUCTS

SCHEDULED DOOR HARDWARE

General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

HANGING DEVICES

Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.

Quantity: Provide the following hinge quantity, unless otherwise indicated:

Two Hinges: For doors with heights up to 60 inches.
Three Hinges: For doors with heights 61 to 90 inches.
Four Hinges: For doors with heights 91 to 120 inches.
For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.

Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

Hinge Options: Comply with the following where indicated in the Hardware Sets or on Drawings:

Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:

Out-swinging exterior doors.
Out-swinging access controlled doors.
Out-swinging lockable doors.

Acceptable Manufacturers:

Hager Companies (HA).
McKinney Products (MK).
Stanley Hardware (ST).

Continuous Geared Hinges: ANSI/BHMA A156.26 certified continuous geared hinge with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Provide concealed flush mount (with or without inset), full surface, or half surface, in standard and heavy duty models, as specified in the Hardware Sets. Concealed continuous hinges to be U.L. listed for use on up to and including 90 minute rated door installations and U.L. listed for windstorm components where applicable. Factory cut hinges for door size and provide with removable service power transfer panel where indicated at electrified openings.

Acceptable Manufacturers:

Bommer Industries (BO).
McKinney Products (MK).
Pemko Manufacturing (PE).

POWER TRANSFER DEVICES

Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

Acceptable Manufacturers:

Corbin Russwin (RU) - EPTL.
McKinney (MK) - EL-EPT.
Securitron (SU) - EL-CEPT Series.
Von Duprin (VD) - EPT-10 Series.

Electric Door Hardware Cords: Provide electric transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

Acceptable Manufacturers:

McKinney Products (MK) – QC-C Series.

Provide one each of the following tools as part of the base bid contract:

- a. McKinney Products (MK) - Electrical Connecting Kit: QC-R001.
McKinney Products (MK) - Connector Hand Tool: QC-R003.

DOOR OPERATING TRIM

Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified automatic, self-latching, and manual flush bolts and surface bolts. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor. Furnish dust proof strikes for bottom bolts. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

Acceptable Manufacturers:

Door Controls International (DC).
Rockwood Manufacturing (RO).
Trimco (TC).

Door Push Plates and Pulls: ANS/BHMA A156.6 certified door pushes and pulls of type and design specified below or in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.

Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.

Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.

Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.

Acceptable Manufacturers:

Hiawatha, Inc. (HI).
Rockwood Manufacturing (RO).
Trimco (TC).

CYLINDERS AND KEYING

General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

Cylinders: Original manufacturer cylinders complying with the following:

Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.

Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.

Bored-Lock Type: Cylinders with tailpieces to suit locks.

Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.

Keyway: Manufacturer's Standard.

Patented Cylinders: ANSI/BHMA A156.5, Grade 1, certified cylinders employing a utility patented and restricted keyway requiring the use of patented controlled keys. Provide bump resistant, fixed core cylinders as standard with solid recessed cylinder collars. Cylinders are to be factory keyed where permanent keying records will be established and maintained.

Provide a 6 pin multi-level master key system comprised of patented controlled keys and security and high security cylinders operated by one (1) key of the highest level. Geographical exclusivity to be provided for all security and high security cylinders and UL437 certification where specified.

Level 1 Cylinders: Provide utility patented controlled keyway cylinders that are furnished with patented keys available only from authorized distribution.

Level 2 Cylinders: Provide utility patented controlled keyway and side bar locking incorporating unique angled bottom pins for geographical exclusivity. Cylinders constructed to provide protection against bumping and picking.

Level 3 Cylinders: Provide utility patented controlled keyway and side bar locking incorporating unique angled bottom pins for geographical exclusivity. Cylinders to be UL437 certified and constructed to provide protection against bumping, picking, and drilling.

Refer to hardware sets for specified levels.

Acceptable Manufacturer:

Sargent Manufacturing (SA) - Degree Series.

Corbin Russwin (RU) – Access 3 Series.

Keying System: Each type of lock and cylinders to be factory keyed. Conduct specified "Keying Conference" to define and document keying system instructions and requirements. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner. Incorporate decisions made in keying conference, and as follows:

Master Key System: Cylinders are operated by a change key and a master key.

Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.

Great-Grand Master Key System: Cylinders are operated by a change key, a master key, a grand master key, and a great-grand master key.

Existing System: Master key or grand master key locks to Owner's existing system.

Keyed Alike: Key all cylinders to same change key.

Key Quantity: Provide the following minimum number of keys:

Top Master Key: One (1)

Change Keys per Cylinder: Two (2)

Master Keys (per Master Key Group): Two (2)

Grand Master Keys (per Grand Master Key Group): Two (2)

Construction Keys (where required): Ten (10)

Construction Control Keys (where required): Two (2)

Permanent Control Keys (where required): Two (2)

Construction Keying: Provide construction master keyed cylinders or temporary keyed construction cores where specified. Provide construction master keys in quantity as required by project Contractor. Replace construction cores with permanent cores. Furnish permanent cores for installation as directed under specified "Keying Conference".

Key Registration List: Provide keying transcript list to Owner's representative in the proper format for importing into key control software.

Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

Acceptable Manufacturers:

Lund Equipment (LU).

MMF Industries (MM).

Telkee (TK).

Key Control Software: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge. Provide factory key system formatted for importing into "Key Wizard" software.

MECHANICAL LOCKS AND LATCHING DEVICES

Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified mortise locksets furnished in the functions as specified in the Hardware Sets. Locksets to be manufactured with a corrosion resistant, stamped 12 gauge minimum formed steel case and be field-reversible for handing without disassembly of the lock body. Lockset trim (including knobs, levers, escutcheons, roses) to be the product of a single manufacturer. Furnish with standard 2 3/4" backset, 3/4" throw anti-friction stainless steel latchbolt, and a full 1" throw stainless steel bolt for deadbolt functions.

Acceptable Manufacturers:

Corbin Russwin Hardware (RU) – ML2000 Series.

Sargent Manufacturing (SA) – 8200 Series.

Yale Locks and Hardware (YA) – 8800FL Series.

Lock Trim Design: As specified in Hardware Sets.

LOCK AND LATCH STRIKES

Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

Standards: Comply with the following:

Strikes for Mortise Locks and Latches: BHMA A156.13.

Strikes for Bored Locks and Latches: BHMA A156.2.

Strikes for Auxiliary Deadlocks: BHMA A156.5.

Dustproof Strikes: BHMA A156.16.

CONVENTIONAL EXIT DEVICES

B. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.

Fire Exit Removable Mullions: Provide keyed removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions to be used only with exit devices for which they have been tested.

Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is not acceptable except in any case where the door light extends behind the device as in a full glass configuration.

Flush End Caps: Provide heavy weight impact resistant flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.

Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty trim with cold forged escutcheons, beveled edges, and four threaded studs for thru-bolts.

Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets. Provided free-wheeling type trim where indicated.

Where function of exit device requires a cylinder, provide an interchangeable core type keyed cylinder (Rim or Mortise) as specified in Hardware Sets.

Vertical Rod Exit Devices: Provide and install interior surface and concealed vertical rod exit devices as Less Bottom Rod (LBR) unless otherwise indicated.

Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.

Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

Rail Sizing: Provide exit device rails factory sized for proper door width application.

Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature.

Acceptable Manufacturers:

Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
Sargent Manufacturing (SA) - 80 Series.
Yale Locks and Hardware (YA) - 7000 Series.

1.2 ELECTROMECHANICAL CONVENTIONAL EXIT DEVICES

A. Electrified Conventional Push Rail Devices (Heavy Duty): Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified below.

1. Acceptable Manufacturers:

Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
Sargent Manufacturing (SA) - 80 Series.
Yale Locks and Hardware (YA) - 7000 Series.

Electrified Options: As indicated in hardware sets, provide electrified exit device options including: electric latch retraction, electric dogging, outside door trim control, exit alarm, delayed egress, latchbolt monitoring, lock/unlock status monitoring, touchbar monitoring and request-to-exit signaling. Unless otherwise indicated, provide electrified exit devices standard as fail secure.

DOOR CLOSERS

All door closers specified herein shall meet or exceed the following criteria:

2. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.

Standards: Closers to comply with UL-10C and UBC 7-2 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.

Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.

Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.

Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.

Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics. Provide drop plates or other accessories as required for proper mounting.

Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as specified in the door Hardware Sets.

Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

Acceptable Manufacturers:

Corbin Russwin Hardware (RU) - DC8000 Series.

Sargent Manufacturing (SA) - 351 Series.

Norton Door Controls (NO) - 7500 Series.

Yale Locks and Hardware (YA) - 4400 Series.

ARCHITECTURAL TRIM

Door Protective Trim

3. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
4. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
5. Metal Protection Plates: ANSI/BHMA A156.6 certified metal protection plates (kick, armor, or mop), beveled on four edges (B4E), fabricated from the following:

Stainless Steel: 300 series, .050-inch thick, with countersunk screw holes (CSK).

Fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets.

Metal Door Edging: Door protection edging fabricated from a minimum .050-inch thick metal sheet, formed into an angle or "U" cap shapes, surface or mortised mounted onto edge of door. Provide appropriate leg overlap to account for protection plates as required. Height to be as specified in the Hardware Sets.

Acceptable Manufacturers:

Hiawatha, Inc. (HI).
Rockwood Manufacturing (RO).
Trimco (TC).

DOOR STOPS AND HOLDERS

- B. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

Acceptable Manufacturers:

Hiawatha, Inc. (HI).
Rockwood Manufacturing (RO).
Trimco (TC).

Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

Acceptable Manufacturers:

Rixson Door Controls (RF).
Rockwood Manufacturing (RO).
Sargent Manufacturing (SA).

ARCHITECTURAL SEALS

- C. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- D. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- E. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and UBC 7-2, Fire Tests of Door Assemblies.

Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

Acceptable Manufacturers:

Pemko Manufacturing (PE).
Reese Enterprises, Inc. (RS).
Zero International (ZE).

1.3 ELECTRONIC ACCESSORIES

Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

Acceptable Manufacturers:

Corbin Russwin Hardware (RU) – 782.
Sargent Manufacturing (SA) – 3500 Series.
Securitron (SU) - BPS Series.
Yale Locks and Hardware (YA) 782.

1.4 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

1.5 FINISHES

Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

- A. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

EXECUTION

EXAMINATION

Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

1.6 PREPARATION

Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

Wood Doors: Comply with ANSI/DHI A115-W series.

INSTALLATION

Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."

Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

FIELD QUALITY CONTROL

Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

ADJUSTING

Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

CLEANING AND PROTECTION

Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

Clean adjacent surfaces soiled by door hardware installation.

Clean operating items as necessary to restore proper finish. and provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

DEMONSTRATION

Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

DOOR HARDWARE SCHEDULE

The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

A. Manufacturer's Abbreviations:

1. MK - McKinney
2. RO - Rockwood
3. SA - Sargent
4. AD - Adams Rite
5. SU - Securitron
6. HS - HES
7. RF - Rixson
8. NO - Norton
9. PE - Pemko
10. 00 - Other
11. LU - Lund Equipment Co., Inc.

Hardware Schedule**Set: 1.0**

Doors: Z101

1 Continuous Hinge	MCK-25HD EPT x LAR	CL	MK
1 Exit Device	DG2 53 55 56 63 8804 ETL	US32D	SA
1 Door Closer	CPS7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Threshold	1715A MSES10SS		PE
1 Gasketing	S88D (Head & Jambs)		PE
1 Sweep	3452CNB x LAR		PE
1 eLynx Frame Harness	QC-C1500P		MK
1 eLynx Door Harness	QC-C*** (Length / Type as Required)		MK
1 Electric Power Transfer	EL-CEPT		SU
1 Power Supply	BPS (size & type as required)		SU

Notes: CARD READER/ KEYPAD BY OTHERS. PRESENTING AUTHORIZED CREDENTIAL TO CARD READER/ KEYPAD WILL UNLOCK EXIT DEVICE ALLOWING ACCESS. EGRESS IS BY EXIT DEVICE. EMERGENCY ACCESS BY KEY. TOUCH RAIL IS MONITORED.

Set: 2.0

Doors: A110

1 Continuous Hinge	MCK-25HD EPT x LAR	CL	MK
1 Exit Device	DG2 53 55 56 63 8804 ETL	US32D	SA
1 Door Closer	PR7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
1 Threshold	2005AT x LAR MSES25SS		PE
1 Gasketing	S88D (Head & Jambs)		PE
1 Rain Guard	347A		PE
1 eLynx Frame Harness	QC-C1500P		MK
1 eLynx Door Harness	QC-C*** (Length / Type as Required)		MK
1 Electric Power Transfer	EL-CEPT		SU
1 Power Supply	BPS (size & type as required)		SU

Notes: CARD READER/ KEYPAD BY OTHERS. PRESENTING AUTHORIZED CREDENTIAL TO CARD READER/ KEYPAD WILL UNLOCK EXIT DEVICE ALLOWING ACCESS. EGRESS IS BY EXIT DEVICE. EMERGENCY ACCESS BY KEY. TOUCH RAIL IS MONITORED.

Set: 3.0

Doors: A102

1 Continuous Hinge	MCK-25HD EPT x LAR	CL	MK
1 Electric Exit Device	DG2 59 63 8876-24v ETL	US32D	SA
1 Door Closer	CPS7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
1 Threshold	1715A MSES10SS		PE
1 Gasketing	S88D (Head & Jambs)		PE
1 Rain Guard	347A		PE
1 Door Bottom	2221APK		PE
1 eLynx Frame Harness	QC-C1500P		MK
1 eLynx Door Harness	QC-C*** (Length / Type as Required)		MK
1 Electric Power Transfer	EL-CEPT		SU
1 Power Supply	BPS (size & type as required)		SU

Notes: CARD READER BY OTHERS. PRESENTING AUTHORIZED CREDENTIAL TO CARD READER WILL SHUNT THE DELAYED EGRESS FEATURE OF EXIT DEVICE AND UNLOCK TRIM. PUSHING TOUCH BAR WITHOUT USING CARD READER WILL ACTIVATE ALARM AND EXIT DEVICE WILL LOCK TOUCH BAR AND LATCH FOR 15 SECONDS. AFTER 15 SECONDS THE TOUCH BAR WILL RELEASE ALLOWING EGRESS. ACTIVATION OF FIRE ALARM WILL TURN OFF DELAYED EGRESS.

ACCESS BY LEVER.

Set: 4.0

Doors: A106

1 Continuous Hinge	MCK-25HD x LAR	CL	MK
1 Storeroom Lock	DG2 63 8204 LNL	US26D	SA
1 Door Closer	CPS7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Threshold	1715A MSES10SS		PE
1 Gasketing	S88D (Head & Jambs)		PE
1 Rain Guard	347A		PE
1 Door Bottom	2221APK		PE

Set: 5.0

Doors: Z102

1 Continuous Hinge	MCK-25HD x LAR	CL	MK
1 Exit Device	12 8815 ETL	US32D	SA
1 Door Closer	PR7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE

Set: 6.0

Doors: B108

1 Continuous Hinge	MCK-25HD EPT x LAR	CL	MK
1 Exit Device	DG2 53 55 56 63 8804 ETL	US32D	SA
1 Door Closer	CLP7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
3 Silencer	608		RO
1 eLynx Frame Harness	QC-C1500P		MK
1 eLynx Door Harness	QC-C*** (Length / Type as Required)		MK
1 Electric Power Transfer	EL-CEPT		SU
1 Power Supply	BPS (size & type as required)		SU

Notes: CARD READER/ KEYPAD BY OTHERS. PRESENTING AUTHORIZED CREDENTIAL TO CARD READER/ KEYPAD WILL UNLOCK EXIT DEVICE ALLOWING ACCESS. EGRESS IS BY EXIT DEVICE. EMERGENCY ACCESS BY KEY. TOUCH RAIL IS MONITORED.

Set: 7.0

Doors: A209, B107.2

6 Hinge	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
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2 Manual Flush Bolt	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	DG2 63 8204 LNL	US26D	SA
2 Surface Overhead Holder/Stop	10-046	630	RF
2 Silencer	608		RO

Set: 8.0

Doors: A201.2, A202.2, B102.1, B104.1, B113.2, B114.2, B200.2, B201.2

3 Hinge	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	DG2 63 8204 LNL	US26D	SA
1 Door Stop	409	US32D	RO
3 Silencer	608		RO

Set: 9.0

Doors: A204

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	DG2 63 8204 LNL	US26D	SA
1 Door Closer	7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
3 Silencer	608		RO

Set: 10.0

Doors: Z103

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	DG2 63 8204 LNL	US26D	SA
1 Door Closer	7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE

Set: 11.0

Doors: B110

3 Hinge	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	DG2 63 8204 LNL	US26D	SA
1 Door Closer	CLP7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE

Set: 12.0

Doors: A100.3

3 Hinge	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	DG2 63 8204 LNL	US26D	SA
1 Door Closer	CLP7500	689	NO
1 Electromagnetic Holder	998 x Voltage as Required	689	RF
1 Gasketing	S88D (Head & Jambs)		PE

Notes: MAGNETIC HOLDER TO BE RELEASED BY FIRE ALARM ACTIVATION.

Set: 13.0

Doors: A201.1, A202.1, B103, B104, B114.1

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Office Lock	DG2 63 8205 LNL	US26D	SA
1 Door Stop	409	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE
1 Door Bottom	411ANBL		PE

Set: 14.0

Doors: A108

1 Continuous Hinge	MCK-12HD x LAR	CL	MK
1 Office Lock	DG2 63 8205 LNL	US26D	SA
1 Door Closer	PR7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE

Set: 15.0

Doors: A205, B200.1, B201.1

1 Continuous Hinge	MCK-12HD x LAR	CL	MK
1 Office Lock	DG2 63 8205 LNL	US26D	SA
1 Door Closer	7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE

Set: 16.0

Doors: A200

1 Continuous Hinge	MCK-12HD x LAR	CL	MK
1 Passage Set	8215 LNL	US26D	SA

1 Door Closer	CLP7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
3 Silencer	608		RO

Set: 17.0

Doors: A207, A208

3 Hinge	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	DG2 63 8237 LNL	US26D	SA
1 Door Stop	409	US32D	RO
3 Silencer	608		RO

Set: 18.0

Doors: B100.2

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	DG2 63 8237 LNL	US26D	SA
1 Door Closer	7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE

Set: 19.0

Doors: B107, B109

3 Hinge	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	DG2 63 8237 LNL	US26D	SA
1 Door Closer	PR7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Door Stop	409	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE

Set: 20.0

Doors: Z201

3 Hinge	TA2714 NRP 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	DG2 63 8237 LNL	US26D	SA
1 Door Closer	PR7500	689	NO
1 Kickplate	K1050 10" high 4BE	US32D	RO
1 Electromagnetic Holder	998 x Voltage as Required	689	RF
1 Gasketing	S88D (Head & Jambs)		PE

Notes: MAGNETIC HOLDER TO BE RELEASED BY FIRE ALARM ACTIVATION.

Set: 21.0

Doors: A206

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Privacy Set	49 8265 LNL	US26D	SA
1 Door Stop	409	US32D	RO
3 Silencer	608		RO

Set: 22.0

Doors: B101, B112.1, Z203

1 Continuous Hinge	MCK-12HD EPT x LAR	CL	MK
1 Fail Secure Electric Lock	DG2 LX RX 8271-24V LNL	US26D	SA
1 Door Closer	CLP7500	689	NO
3 Silencer	608		RO
1 eLynx Frame Harness	QC-C1500P		MK
1 eLynx Door Harness	QC-C*** (Length / Type as Required)		MK
1 Electric Power Transfer	EL-CEPT		SU
1 Battery Backup	B-12 / 24-5 (as required)		SU

Notes: CARD READER/ KEYPAD BY OTHERS. PRESENTING AUTHORIZED CREDENTIAL TO CARD READER/ KEYPAD WILL UNLOCK EXTERIOR TRIM ALLOWING ACCESS. EGRESS IS BY INSIDE LEVER WHICH IS MONITORED. EMERGENCY ACCESS BY KEY.

Set: 23.0

Doors: A203

1 Continuous Hinge	MCK-12HD EPT x LAR	CL	MK
1 Fail Secure Electric Lock	DG2 LX RX 8271-24V LNL	US26D	SA
1 Door Closer	7500	689	NO
1 Door Stop	409	US32D	RO
1 Gasketing	S88D (Head & Jambs)		PE
1 eLynx Frame Harness	QC-C1500P		MK
1 eLynx Door Harness	QC-C*** (Length / Type as Required)		MK
1 Electric Power Transfer	EL-CEPT		SU
1 Battery Backup	B-12 / 24-5 (as required)		SU

Notes: CARD READER/ KEYPAD BY OTHERS. PRESENTING AUTHORIZED CREDENTIAL TO CARD READER/ KEYPAD WILL UNLOCK EXTERIOR TRIM ALLOWING ACCESS. EGRESS IS BY INSIDE LEVER WHICH IS MONITORED. EMERGENCY ACCESS BY KEY.

Set: 24.0

Doors: B101.1, B111, B112.2, B203, B205, B206, B210

1 Continuous Hinge	MCK-12HD EPT x LAR	CL	MK
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1 Fail Secure Electric Lock	DG2 LX RX 8271-24V LNL	US26D	SA
1 Door Closer	CLP7500	689	NO
1 Gasketing	S88D (Head & Jambs)		PE
1 eLynx Frame Harness	QC-C1500P		MK
1 eLynx Door Harness	QC-C*** (Length / Type as Required)		MK
1 Electric Power Transfer	EL-CEPT		SU
1 Battery Backup	B-12 / 24-5 (as required)		SU

Notes: CARD READER/ KEYPAD BY OTHERS. PRESENTING AUTHORIZED CREDENTIAL TO CARD READER/ KEYPAD WILL UNLOCK EXTERIOR TRIM ALLOWING ACCESS. EGRESS IS BY INSIDE LEVER WHICH IS MONITORED. EMERGENCY ACCESS BY KEY.

Set: 25.0

Doors: B107.1, B109.1

1 Continuous Hinge	MCK-12HD x LAR	CL	MK
1 Push Plate	70C	US32D	RO
1 Pull Plate	110x70C	US32D	RO
1 Door Closer	CLP7500	689	NO
1 Gasketing	S88D (Head & Jambs)		PE
3 Silencer	608		RO

Set: 26.0

Doors: A100.1, A100.2

1 Hardware	By Door Manufacturer		00
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Set: 27.0

Doors: A101, A101.1, A103, A103.1, A103.2, A107, A109, A111, Z100

1 Detention Door Hardware	By Door Manufacturer		00
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Set: 28.0

Doors: B100.1, B102, B106, B113.1, B204, B207, B208, B209

1 Existing Door, Frame	and Hardware		00
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Notes: REUSE EXISTING HARDWARE. DOOR AND FRAME IS EXISTING. VERIFY LOCKSET/ EXIT TYPE. VERIFY HINGES AND EXISTING HARDWARE IS IN GOOD CONDITION AND INSTALLED CORRECTLY.

Set: 29.0

Doors: MISC

1 Repair Kit	QC-R001		MK
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1 Crimp Tool	QC-R003	MK
1 Wiring Diagram	WD-SYSPK (Elevations and Point to Point)	SA
1 Key Cabinet	1205	LU

END OF SECTION 087100

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Metal Doors and Frames".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 80 - Fire Doors and Windows.
 - 4. NFPA 101 - Life Safety Code.
 - 5. NFPA 105 - Installation of Smoke Door Assemblies.
 - 6. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards:
 - 1. ANSI/BHMA Certified Product Standards - A156 Series
 - 2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.
- D. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- E. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.
- 1.4 QUALITY ASSURANCE
- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
 - B. Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum 3 years documented experience installing both standard and electrified builders hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
 - C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical

hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor in good standing by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- D. Source Limitations: Obtain each type and variety of Door Hardware specified in this Section from a single source, qualified supplier unless otherwise indicated.
1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:
1. NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 2. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:
 - a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
 - b. Door Closers: Comply with the following maximum opening-force requirements indicated:
 - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
 - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.
 3. NFPA 101: Comply with the following for means of egress doors:
 - a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
 - b. Thresholds: Not more than 1/2 inch high.
 4. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 (neutral pressure at 40" above sill) or UL-10C.

- a. Test Pressure: Positive pressure labeling.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
- 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
- 1. Prior to installation of door hardware, arrange for manufacturers' representatives to hold a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Review sequence of operation narratives for each unique access controlled opening.
 - 3. Review and finalize construction schedule and verify availability of materials.
 - 4. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
 - B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
 - C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".
- 1.6 COORDINATION
- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

- B. Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Five years for exit hardware.
 - 3. Twenty five years for manual surface door closers.

1.8 MAINTENANCE SERVICE

- 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.
- B. Continuing Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

1. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - a. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- B. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.
 1. Hinge Options: Comply with the following where indicated in the Hardware Sets or on Drawings:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:
 - 1) Out-swinging exterior doors.
 - 2) Out-swinging access controlled doors.
 - 3) Out-swinging lockable doors.
 2. Acceptable Manufacturers:
 - a. Bommer (BO).
 - b. Hager Companies (HA).
 - c. McKinney Products (MK).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 certified continuous geared hinge with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Provide concealed flush mount (with or without inset), full surface, or half surface, in standard and heavy duty models, as specified in the Hardware Sets. Concealed continuous hinges to be U.L. listed for use on up to and including 90 minute rated door installations and U.L. listed for windstorm components where applicable. Factory cut hinges for door size and provide with removable service power transfer panel where indicated at electrified openings.
 1. Acceptable Manufacturers:
 - a. Bommer Industries (BO).
 - b. McKinney Products (MK).
 - c. Pemko Manufacturing (PE).

2.3 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified automatic, self-latching, and manual flush bolts and surface bolts. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor. Furnish dust proof strikes for bottom bolts. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
1. Acceptable Manufacturers:
 - a. Ives (I).
 - b. Rockwood Manufacturing (RO).
 - c. Trimco (TC).
- B. Door Push Plates and Pulls: ANS/BHMA A156.6 certified door pushes and pulls of type and design specified below or in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, 4-inches wide by 16-inches high, with square corners and beveled edges, secured with exposed screws unless otherwise indicated.
 2. Straight Pull Design: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection from face of door unless otherwise indicated.
 3. Offset Pull Design: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection and offset of 90 degrees unless otherwise indicated.
 4. Push Bars: Minimum 1-inch round diameter horizontal push bars with minimum clearance of 2 1/2-inch projection from face of door unless otherwise indicated.
 5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 - a. Acceptable Manufacturers:
 - 1) Ives (I)
 - 2) Rockwood Manufacturing (RO).
 - 3) Trimco (TC).

2.4 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. Cylinders: Original manufacturer cylinders complying with the following:
1. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 4. Keyway: Manufacturer's Standard.

- D. Patented Cylinders: ANSI/BHMA A156.5, Grade 1, certified cylinders employing a utility patented and restricted keyway requiring the use of patented controlled keys. Provide bump resistant, fixed core cylinders as standard with solid recessed cylinder collars. Cylinders are to be factory keyed where permanent keying records will be established and maintained.
1. Provide a 6 pin multi-level master key system comprised of patented controlled keys and security and high security cylinders operated by one (1) key of the highest level. Geographical exclusivity to be provided for all security and high security cylinders and UL437 certification where specified.
 2. Acceptable Manufacturer:
 - a. Corbin Russwin (RU) – AS Series
 - b. Sargent Manufacturing (SAR) - Degree Series.
 - c. Schlage (SC) – Primus XP Series.
- E. Keying System: Each type of lock and cylinders to be factory keyed. Conduct specified "Keying Conference" to define and document keying system instructions and requirements. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner. Incorporate decisions made in keying conference, and as follows:
1. Master Key System: Cylinders are operated by a change key and a master key.
 2. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.
 3. Great-Grand Master Key System: Cylinders are operated by a change key, a master key, a grand master key, and a great-grand master key.
 4. Existing System: Master key or grand master key locks to Owner's existing system.
- F. Key Quantity: Provide the following minimum number of keys:
1. All Master Key Levels: Six (6)
 2. Change Keys per Cylinder: Four (4)
 3. Permanent Control Keys (where required): Two (2)
- G. Key Registration List: Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
- H. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall expansion capacity of 150% of the number of locks required for the project.
1. Acceptable Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).
- I. Key Control Software: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge. Provide factory key system formatted for importing into "Key Wizard" software.

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified mortise locksets furnished in the functions as specified in the Hardware Sets. Locksets to be manufactured with a corrosion resistant, stamped 12 gauge minimum formed steel case and be field-reversible for handing without disassembly of the lock body. Lockset trim (including knobs, levers, escutcheons, roses) to be the product of a single manufacturer. Furnish with standard 2 3/4" backset, 3/4" throw anti-friction stainless steel latchbolt, and a full 1" throw stainless steel bolt for deadbolt functions.
1. Acceptable Manufacturers:
- a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. Sargent Manufacturing (SA) – 8200 Series.
 - c. Schlage (SC) – L9000 Series.
- B. Lock Trim Design: As specified in Hardware Sets.

2.6 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated.
- B. Standards: Comply with the following:
1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 3. Strikes for Auxiliary Deadlocks: BHMA A156.5.
 4. Dustproof Strikes: BHMA A156.16.

2.7 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
 2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
 3. Except on fire rated doors, provide exit devices with keyed cylinder dogging, unless noted otherwise on devices where specified in Hardware Sets.
 4. Flush End Caps: Provide heavy weight impact resistant flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.

5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty trim with cold forged escutcheons, beveled edges, and four threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets. Provided free-wheeling type trim where indicated.
 - b. Where function of exit device requires a cylinder, provide an interchangeable core type keyed cylinder (Rim or Mortise) as specified in Hardware Sets.
 6. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 7. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED5000 Series.
 - b. Sargent Manufacturing (SA) - 80 Series.
 - c. Von Duprin (VD) - 98 XP Series.
- C. Tube Steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish. Provide keyed removable feature, stabilizers, and mounting brackets as specified in the Hardware Sets. At openings designed for severe wind load conditions due to hurricanes or tornadoes, provide manufacturers approved mullion and accessories to meet applicable state and local windstorm codes.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - 900 Series.
 - b. Sargent Manufacturing (SA) - 980S Series.
 - c. Von Duprin (VD) - 9954 Series.

2.8 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
 2. Standards: Closers to comply with UL-10C and UBC 7-2 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of

use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 - a. Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.
 - b. Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.
 - c. Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.
 - d. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics. Provide drop plates or other accessories as required for proper mounting.
 5. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as specified in the door Hardware Sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC8000 Series.
 - b. LCN Closers (LC) - 4040XP Series.
 - c. Sargent Manufacturing (SA) - 351 Series.
 - d. Norton Door Controls (NO) - 7500 Series.
- C. Door Closers, Surface Mounted (Cam Action): ANSI/BHMA 156.4, Grade 1 certified surface mounted, high efficiency door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be of the cam and roller design, one piece cast aluminum silicon alloy body with adjustable backcheck and independently controlled valves for closing sweep and latch speed.
1. Acceptable Manufacturers:
 - a. Corbin Russwin (RU) - DC5000 Series.
 - b. Norton Door Controls (NO) - 2800ST Series.
 - c. Sargent Manufacturing (SA) - 421 Series.

2.9 ARCHITECTURAL TRIM

- A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Metal Protection Plates: ANSI/BHMA A156.6 certified metal protection plates (kick, armor, or mop), beveled on four edges (B4E), fabricated from the following.
 - a. Stainless Steel: 050-inch thick, with countersunk screw holes (CSK).
4. Fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets.
5. Acceptable Manufacturers:
 - a. Ives (I).
 - b. Rockwood Manufacturing (RO).
 - c. Trimco (TC).

2.10 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 1. Acceptable Manufacturers:
 - a. Ives (I)
 - b. Rockwood Manufacturing (RO).
 - c. Trimco (TC).

2.11 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.
- C. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

- D. Acceptable Manufacturers:
1. Pemko Manufacturing (P).
 2. Reese Enterprises, Inc. (RS).
 3. Zero International (ZE).

2.12 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.13 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.

- C. Clean operating items as necessary to restore proper finish, and provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SCHEDULE

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

- B. Manufacturer Abbreviations:

1.	ABH Manufacturing Inc.	AB
2.	McKinney	MC
3.	Pemko	PE
4.	Rockwood	RO
5.	Sargent	SA

- C. Hardware Sets:

Hardware Set #01 (Exterior single exit doors)

100.1 EXTERIOR to CORRIDOR

Each opening to receive:

1 EA	Door Wiring Harness	QC-C1500P		MC
1 EA	Door Wiring Harness	QC-AS REQUIRED		MC
1 EA	Continuous Hinge	FM200		MC
1 EA	Rim Exit Device	BL7300 Series	US26D	SA
1 EA	Door Closer	351 PS	EN	SA
1 EA	Protection Plate	K1050 8" x 34"	US26D	RO
1 EA	Weatherstripping	S88 BL 20'		PE
1 EA	Rain drip	346 C		PE
1 EA	Threshold	1716 A 44"		PE
1 EA	Door Sweep	18061 CNB		PE

Hardware Set #01A (Exterior single exit doors)

- 006.1 EXTERIOR to STORAGE (ALT #4)
107.1 EXTERIOR to MULTIPURPOSE ROOM
111.1 EXTERIOR to MECH/ELEC
130.1 EXTERIOR to EXISTING DRILL SHED

Each opening to receive:

3 EA	Hinges (heavy weight)	TA386 5 X 4 1/2 NRP	US26D	MC
1 EA	Rim Exit Device	8813 Series	US26D	SA
1 EA	Door Closer	351 PS	EN	SA
1 EA	Protection Plate	K1050 8" x 34"	US26D	RO
1 EA	Weatherstripping	S88 BL 20'		PE
1 EA	Rain drip	346 C		PE
1 EA	Threshold	1716 A 44"		PE
1 EA	Door Sweep	18061 CNB		PE

Hardware Set #01B (Exterior single exit doors)

005.1 EXTERIOR to MECH VEST (ALT. #4)

007.1 EXTERIOR to STORAGE (ALT #4)

Each opening to receive:

3 EA	Hinges (heavy weight)	TA386 5 X 4 1/2 NRP	US26D	MC
1 EA	Passage Set	10G15 Series	US26D	SA
1 EA	Door Closer	351 PS	EN	SA
1 EA	Protection Plate	K1050 8" x 34"	US26D	RO
1 EA	Smoke Gasket Seal	S88 BL 20'		PE
1 EA	Rain drip	346 C		PE
1 EA	Threshold	1716 A 44"		PE
1 EA	Door Sweep	18061 CNB		PE

Hardware Set #02 (Exterior double exit doors)

109.1 EXTERIOR to WOMENS LOCKER ROOM

110.1 EXTERIOR to MENS LOCKER ROOM

Each opening to receive:

6 EA	Hinges (heavy weight)	TA386 4 1/2 X 4 1/2 NRP	US26D	MC
2 EA	Rim Exit Device	8713 Series Vert. Rod	US26D	SA
2 EA	Door Closer	351 PS	EN	SA
2 EA	Protection Plate	K1050 8" x 34"	US26D	RO
1 EA	Smoke Gasket Seal	S88 BL 20'		PE
1 EA	Rain drip	346 C		PE
1 EA	Threshold	2005 AP 72"		PE
1 EA	Astragal Insert	3443 S		
1 EA	Door Sweep	18061 CNB		PE

Hardware Set #03 (Interior double doors, FIRE RATED DOORS)

107.2 CORRIDOR 100 to MULTIPURPOSE

118.3 COORIDOR 119A to EXISTING DINING

Each opening to receive:

6 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
2 EA	Rim Exit Device	8713 Series Vert. Rod	US26D	SA
2 EA	Door Closer	351 OD	EN	SA
1 EA	Smoke Gasket Seal	S88 BL 20'		PE
1 EA	Astragal Insert	311 C IN 3.75 84"		PE
1 EA	Door Sweep	18061 CNB		PE

Hardware Set #04 (Interior single doors)

109A.1 WOMEN'S LOCKER ROOM 109 to WOMEN SHOWER 109A
110A.1 MEN'S LOCKER ROOM 110 to MEN SHOWER 110A

Each opening to receive:

3 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
1 EA	Privacy Lock	8265 Series	US26D	SA
1 EA	Protection Plate	K1050 8" x 34"	US26D	RO
1 EA	Wall Bumper	403	US26D	RO
3 EA	Door Silencers	608-RKW	GREY	RO

Hardware Set #04A (Interior single doors)

102.1 ADMIN STORAGE 102 to ADMIN OFFICE 101
127A.1 STORAGE to READINESS NCO 127 (ALT. #2)
128A.1 STORAGE to TRAINING NCO 128 (ALT #2)

Each opening to receive:

3 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
1 EA	Passage Latch	6515 Series	US26D	SA
1 EA	Wall Bumper	403	US26D	RO
3 EA	Door Silencers	608-RKW	GREY	RO

Hardware Set #04B (Interior single doors)

122.1 STORAGE to CONFERENCE ROOM 122 (ALT. #1)
123.1 OFFICER & HQ READY ROOM 125 to OFFICE 123 (ALT. # 2)
124.1 OFFICER & HQ READY ROOM 125 to OFFICE 124 (ALT. # 2)
126.1 OFFICER & HQ READY ROOM 125 to HQ COMMON AREA 126 (ALT # 2)
127.1 HQ COMMON AREA 126 to READINESS NCO 127 (ALT # 2)
128.1 HQ COMMON AREA 126 to TRAINING NCO 128 (ALT # 2)

Each opening to receive:

3 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
1 EA	Entrane Lock	6505 Series	US26D	SA
1 EA	Wall Bumper	403	US26D	RO
3 EA	Door Silencers	608-RKW	GREY	RO

Hardware Set #05 (Interior single doors, 90-minute rated)

119B.1 CORRIDOR 119B to DRILL SHED

Each opening to receive:

3 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
1 EA	90 Min Rim Exit Device	8515 Series	US26D	SA
1 EA	Door Closer	351 P10	EN	SA
1 EA	Electromagnetic Door Holder	1561	EN	SA
1 EA	Wall Bumper	403	US26D	RO
3 EA	Door Silencers	608-RKW	GREY	RO
1 EA	Smoke Gasket Seal	S88 BL 20'		PE

Hardware Set #06 (Interior fire-rated single doors)

- 101.1 CORRIDOR 100 to ADMIN OFFICE 101
- 103.1 CORRIDOR 100 to LACTATION ROOM 103
- 104.1 CORRIDOR 100 to LEARNING CENTER 104
- 105.1 CORRIDOR 100 to FAMILY READINESS 105
- 108.1 CORRIDOR 100 to IT CLOSET 108
- 112.1 CORRIDOR 119 to OFFICE 112
- 113.1 CORRIDOR 119 to OFFICE 113
- 114.1 CORRIDOR 119 to OFFICE 114
- 115.1 CORRIDOR 119 to OFFICE 115
- 116.1 CORRIDOR 119 to OFFICE 116
- 117.1 CORRIDOR 119 to CLASSROOM 117
- 118.1 CORRIDOR 119 to EXISTING DINNING 118A
- 118.2 CORRIDOR 119 to FOOD PREP 118B
- 120.1 CORRIDOR 119B to CLASSROOM 120
- 122.2 CORRIDOR 119A to CONFERENCE ROOM 122
- 125.1 CORRIDOR 119 to OFFICER & HQ READY ROOM 125 (ALT #2)
- 126.2 COOIDOR 119 to HQ COMMON AREA 126 (ALT #2)

Each opening to receive:

3 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
1 EA	Entrane Lock	6505 Series	US26D	SA
1 EA	Door Closer	351 P10	EN	SA
1 EA	Door Silencers	608-RKW	GREY	RO
1 EA	Smoke Gasket Seal	S88 BL 20'		PE

Hardware Set #06A (Interior fire-rated single doors)

- 106.1 CORRIDOR 100 to JC 106

Each opening to receive:

3 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
1 EA	Lockset	10G04 LL	US26D	SA
1 EA	Protection Plate	K1050 8" x 34"	US26D	RO
1 EA	Door Closer	351 P10	EN	SA
1 EA	Door Silencers	608-RKW	GREY	RO
1 EA	Smoke Gasket Seal	S88 BL 20'		PE

Hardware Set #06B (Interior fire-rated single doors)

- 129.1 EXISITNG MECHANICAL to WATER HEATER ROOM 129

Each opening to receive:

3 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
1 EA	Storeroom Lockset	10G04 LL	US26D	SA
1 EA	Protection Plate	K1050 10" x 34"	US26D	RO
1 EA	Door Closer	351 P10	EN	SA
1 EA	Door Silencers	608-RKW	GREY	RO
1 EA	Smoke Gasket Seal	S88 BL 20'		PE

Hardware Set #07 (Interior fire-rated single doors)

107A.1 STORAGE to MULTIPURPOSE ROOM 107
107B.1 STORAGE to MULTIPURPOSE ROOM 107

Each opening to receive:

3 EA	Hinges (heavy weight)	TA786 4 1/2 X 4 1/2 NRP	US26D	MC
1 EA	Lockset	10G04 LL	US26D	SA
1 EA	Half Dummy Trim	10U93 LL	US26D	SA
1 EA	Dust Proof Strike	570	US26D	RO
1 EA	Flush Bolt Set	2845; 2945	US26D	RO
1 EA	Protection Plate	K1050 8" x 34"	US26D	RO
1 EA	Door Silencers	608-RKW	GREY	RO

Hardware Set #08 (Push/pull)

131.1 EXISTING CORRIDOR 119 TO EXISTING WOMEN'S TOILET
131.2 EXISTING CORRIDOR 119B TO EXISTING MEN'S TOILET

Each opening to receive:

1 EA NRP BUTT HINGES US32D
1 EA SURFACE MOUNTED CLOSER PAINTED FINISH
3 EA FRAME MOUNTED SILENCERS
1 EA 3 1/2" X 15" PUSH PLATE US32D
1 EA 3 1/2" X 15" PULL HANDLE W/ PLATE US32D
1 EA WALL MOUNT DOOR STOP
1 EA KICK PLATE ON PUSH SIDE

END OF SECTION 08 71 00

SECTION 08 80 00 - GLASS AND GLAZING

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. Glazing exterior windows or window-wall panels.
 - 2. Glazing exterior entrances and vestibules.
 - 3. Glazing doors.
 - 4. Glazing interior partitions, and miscellaneous interior glazing.
 - 5. Unframed mirrors.

1.3 RELATED SECTIONS:

- A. Related work under other sections:
 - 1. Division 04 Section "Unit Masonry."
 - 2. Division 07 Section "Joint Sealants."
 - 3. Division 08 Section "Aluminum Entrances and Storefronts."
 - 4. Division 08 Section "Aluminum Storefront Windows."
 - 5. Division 08 Section "Steel Doors and Frames."
 - 6. Division 08 Section "Wood Doors."
 - 7. Division 08 Section "Automatic Entrances."

1.4 QUALITY ASSURANCE:

- A. Manufacturer of Basic Glass: (one of the following)
 - 1. C-E Glass Division
 - 2. Libbey-Owens-Ford Company (Spectrum)
 - 3. PPG Industries, Inc.
 - 4. Virginia Glass Co.
 - 5. Cardinal Glass Co.

1.5 DEFINITIONS

- A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in reference glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

- C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for 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.

1.6 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
 - 1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Specified Design Wind Loads: As required by Code.
 - b. Specified Design Snow Loads for Sloped Glazing: As required by Code.
 - c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
 - 1) Load Duration: 60 seconds or less.
 - d. Probability of Breakage for Sloped Glazing: 1 lite per 1000 for lites set more than 15 degrees off vertical and under wind and snow action.
 - 1) Load Duration: 30 days.
 - e. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side strength or 1 inch, whichever is less.
 - 1) For monolithic-glass lites heat-treated to resist wind loads.

- 2) For insulating glass.
 - 3) For laminated-glass lites.
- f. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.
- C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
1. For monolithic glass lites, properties are based on units with lites 6.0 mm thick.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units with lites 6.0 mm thick and have a nominal 1/2-inch-wide interspace.
 4. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
 - a. U-Factors: NFRC 100 expressed as Btu/sq. ft. x h x deg F.
 - b. Solar Heat Gain Coefficient: NFRC 200.
 - c. Solar Optical Properties: NFRC 300.

1.7 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Samples: Submit 12" x 12" x 1" manufacturers/fabricators samples of each glass Type and any alternate samples that may be requested by the Architect. Samples to match exactly the glass specifications, manufacturing techniques, thickness, color, and coatings and include the following:
1. Each color of tinted float glass.
 2. Each type of patterned glass.
 3. Coated vision glass.
 4. Ceramic-coated spandrel glass.
 5. Each pattern and color of ceramic-coated vision glass.
 6. Wired glass.
 7. Mirror glass.
 8. Fire-resistive glazing products.
 9. Each type of laminated glass with colored interlayer.
 10. Insulating glass for each designation indicated.
 11. For each color (except black) of exposed glazing sealant indicated.
 12. Evaluation of proposed substitutions will be on the basis of color and performance as determined by the Architect.
- C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

- D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
 - 1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.
- E. Qualification Data: For installers.
- F. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.
- G. Product Test Reports: For each of the following types of glazing products.
 - 1. Tinted float glass.
 - 2. Coated float glass.
 - 3. Insulating glass.
 - 4. Glazing sealants.
 - 5. Glazing gaskets.
- H. Warranties: Special warranties specified in this Section.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance.
- B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: clear float glass, laminated glass and insulating glass.
- C. Source Limitations for Glass Sputter-Coated with Solar Control Low-E Coatings: Where solar-control low-e coatings of a primary glass manufacturer that has established a certified fabricator program is specified, obtain sputter-coated solar-control low-e coated glass in fabricated units from a manufacturer that is certified by coated-glass manufacturer.
- D. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- E. Elastometric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
 - 1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Test elastometric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
- F. Preconstruction Adhesion and Compatibility Testing: Submit to elastometric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastometric glazing sealants:

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
 2. Submit not fewer than eight pieces of each type 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 sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
 5. Testing will not be required if elastometric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.
- G. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
- H. Safety Glazing Products: Comply with testing requirements in 16 CFR 120 and, for wired glass, ANSI Z97.1.
1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
 2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. or less in exposed surface area of one side, providing glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.
- I. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations 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: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual".
 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Sloped Glazing Guidelines."
 4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."
- J. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:
1. Insulating Glass Certification Council.
- K. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Comply with Division 01 requirements. Glass manufacturer and fabricator must obtain Architect's written acceptance of mock-ups prior to proceeding with fabrication and installation.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturers written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.10 JOB CONDITIONS:

- A. Examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glazing is to be performed, and notify the Contractor in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the glazing until unsatisfactory conditions have been corrected.
- B. 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 liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Insulated Glass and for Coated-Glass Products: Manufacturer's standard form, made out to the Owner and signed by coated glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: Ten years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made-out to the Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Glass:
 - 1. Wired Glass: FS DD-G-451, Type III, Class I, Kind A (flat), Form I (wired and polished both faces), Mesh m3 (square); U.L. approved, 1/4" thick (nominal) except as otherwise indicated.
 - 2. Plate Glass: Polished plate or float glass; FS DD-G-451, 1/4" thick, except as otherwise indicated.
 - a. Clear: Type I, Class 1, Quality q3.

- b. Tinted: Type I, Class 3, Quality q3, color as selected.
 3. Tempered Safety Glass: Either plate glass or float glass (FS DD-G-1403); which has been heat-strengthened by manufacturer's standard process (after cutting to final size), to achieve a flexural strength of four times normal glass strength; 1/4" thick, except as otherwise indicated.
 - a. Clear: Kind FT, Condition A, Type I, Class 1, Quality q3.
 - b. Tinted: Kind FT, Condition A, Type I, Class 3, Quality q3, color as selected.
- B. Insulating Glass: Manufacturer's standard units of two sheets of 1/4" thick plate or tempered glass as required (inner sheet-clear as specified above; exterior sheet - clear, as specified above); permanently and hermetically sealed together at edges with spacers, sealant and desiccant, etc.; to provide a dehydrated air space 1/2" thick with -60 degrees F. dew point; fabricated to the sizes and shapes indicated. Permanently label all sealed insulating units through the IGCC. Provide units with Class "C" label.
 1. Guarantee: Provide manufacturer's ten (10) year guarantee.
- C. Laminated Glass: Thickness as indicated, consisting of clear, tempered exterior glass, a clear PVB interlayer of .030" thickness and clear, tempered interior glass. Laminated Glass shall meet the current requirements of the ASTM E-1172 "Standard Specification for Laminated Architectural Float Glass." For safety glazing applications, Laminated Glass shall comply with the Consumer Product Safety Commission 16 CFR 1201 and the Safety Glass requirements of ANSI Z-97.1 (current editions).
- D. Spandrel Glass: Fired Ceramic Decorated Glass with a durable glass frit applied to the #2 surface to provide a "solid color". Provide Guardian "Duraspan"; or approved equal, for solid color spandrel. Provide material which has been heat-strengthened or tempered. Provide thicknesses, as detailed; and colors as selected.
- E. Wired Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Quality-Q-6; and form and mesh pattern specified.
- F. Patterned Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Form 3 (patterned); and of quality, finish, and pattern specified.
- G. Fire-Rated Monolithic Ceramic Glazing Material: Proprietary product in the form of clear flat sheets of 3/16-inch nominal thickness weighing 2.5 lb/sq. ft. and as follows:
 1. Fire-Protection Rating: As indicated for the fire window in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Product: "Premium FireLite" (polished on both surfaces) by Nippon Electric Glass Co., Ltd., and distributed by Technical Glass Products.
- H. Fire-Rated Laminated Ceramic Glazing material: Proprietary Category II safety glazing product in the form of 2 lites of clear ceramic glazing material laminated together to produce a laminated lite of 5/16-inch nominal thickness; polished on both surfaces; weighing 4 lb/sq. ft. and as follows:
 1. Fire-Protection Rating: as indicated for the assembly in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Polished on both surfaces, transparent.

3. Product: "FireLite Plus" by Nippon Electric Glass Co., Ltd., and distributed by Technical Glass Products.
 - I. Tempered Clear Glass: Mirror Glazing Quality, for blemish requirements; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
 1. Nominal Thickness: 1/4-inch.
 - J. Translucent Honeycomb Panels: Provide translucent panels and accessories equal to AO/GCL Laminated Series by Panelite LLC.
 - K. Edge Seals: ASTM E 773, with aluminum spacers and silicone sealant for glass spacer seals.
 - L. Sealants: Approved by glass manufacturer, grey color as approved by the Architect.

2.2 SILVERED FLAT GLASS MIRROR MATERIALS

- A. Tempered Clear Glass Mirrors: Comply with ASTM C 1503, Mirror Glazing Quality, for blemish requirements in annealed float glass before silver coating is applied, for coating requirements, and with other requirements not affected by tempering process; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
 1. Nominal Thickness: As indicated.

2.3 GLAZING SEALANTS/COMPOUNDS:

- A. General: Provide products of type indicated, complying with the following requirements:
 1. Compatibility: Verify glazing sealants that are compatible with one another and with other materials they will 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 manufacturer's written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Two-Component Polysulfide Glazing Sealant: Polysulfide two-part elastomeric sealant, complying with FS TT-S-00227 Class A, Type 2 (non-sag); with container bearing Thiokol Chemical Corporation seal of approval; compounded by manufacturer specifically for glazing.
- C. Butyl Rubber Glazing Tape: Partly-vulcanized, self-adhesive, non-staining, elastomeric butyl rubber tape, 98% solids, intended for 35% compression, no appreciable deterioration for 3000 hour test in Atlas Weatherometer.
- D. Acrylic-Latex Glazing Sealant (interior only): Modified latex rubber and acrylic emulsion-polymer, compounded specifically as a glazing sealant with permanent flexibility (non-hardening), non-staining and non-bleeding.
- E. Glazing sealant for fire-resistive glazing products: Identical to products used in test assemblies to obtain fire-protection rating.

2.4 MISCELLANEOUS GLAZING MATERIALS:

- A. Setting Blocks: Neoprene, 70-90 durometer hardness, compatible with sealants used.
- B. Spacers: Neoprene, 40-50 durometer hardness, compatible with sealants used.
- C. Compressible Filler Rod (Cp-FR): Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, compatible with sealants used, flexible and resilient, with 5-10 psi compression strength for 25% deflection.
- D. Cleaners, Primers and Sealers: type recommended by sealant or gasket manufacturer.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Standards and Performance:
 - 1. Watertight and airtight installation of each piece of glass is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the work.
 - 2. Protect glass from edge damage at all times during handling, installation and operation of the building.
 - 3. Glazing channel dimensions, as shown, are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. The Glazier is responsible for correct glass size for each opening, within the tolerances and necessary dimensions established.
 - 4. Comply with combined recommendations of glass manufacturer and manufacturer of sealants and other materials used in glazing, except where more stringent requirements are shown or specified, and except where manufacturer's technical representative direct otherwise.
 - 5. Comply with "Glazing Manual" by Flat Glass Marketing Association except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturer's of the glass and glazing materials.
 - 6. Inspect each piece of glass immediately before installation, and eliminate any which have observable edge damage or face imperfections.
 - 7. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.
 - 8. Install polysulfide sealants as recommended by Thiokol Chemical Corporation, except as otherwise recommended by the sealant manufacturer.

3.2 INSTALLATION:

- A. Preparation of Glazing:
 - 1. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to the substrate. Remove lacquer from metal surfaces where elastomeric sealants are used.
 - 2. Apply primer or sealer to joint surfaces where recommended by sealant manufacturer.

B. Glazing:

1. Glaze all operating sash in closed position.
2. Install setting blocks of proper size at quarter points of sill rabbet. Set blocks in thin course of the heel-bead compound, if any.
3. Provide spacers inside and out, of proper size and spacing, for all glass sizes larger than 50 united inches, except where gaskets are used for glazing. Provide 1/8" minimum bite of spacers on glass and use thickness equal to sealant width; except with sealant tape, use thickness slightly less than final compressed thickness of tape.
4. Voids and Filler Rods: Prevent exudation of sealant or compound by forming voids or installing filler rods in the channel at the heel of jambs and head (do not leave voids in the sill channels) except as otherwise indicated, depending on light size, thickness and type of glass, and complying with manufacturer's recommendations.
5. Do not attempt to cut, seam, nip or abrade glass which is tempered, heat strengthened, or coated.
6. Force sealants into channel to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces.
7. Tool exposed surfaces of glazing liquids and compounds to provide a substantial "wash" away from the glass. Install pressurized tapes and gaskets to protrude slightly out of the channel, so as to eliminate dirt and moisture pockets.
8. Clean and trim excess glazing materials from the glass and stops and frames promptly after installation, and eliminate stains and discolorations.
9. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead.
10. Gasket Glazing: Miter cut and bond ends together at corner, where gaskets are used for channel glazing, so that gaskets will not pull away from corners and result in voids or leaks in the glazing system.

3.3 CURE, PROTECTION AND CLEANING:

- A. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.
- B. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.
- C. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.
- D. Maintain glass in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash-offs) to the deterioration of glazing materials and other work.
- E. Provide final glazing clean, when directed, prior to building/Project completion and final payment.

END OF SECTION 08 80 00

SECTION 09 29 00 - GYPSUM BOARD

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. Interior gypsum board.
- 2. Tile backing panels.

B. Related Requirements:

- 1. Division 07 Section "Sound Attenuation Batts"
- 2. Division 09 Section "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
- 3. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
- 4. Division 09 Section "Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.3 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.

1.4 QUALITY ASSURANCE

- A. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.

- 1. Install mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.

2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 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.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, 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, those that are moisture damaged, and those that are 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.
- C. Low-Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying 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 GYPSUM BOARD, GENERAL

- A. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent.

- B. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Gypsum.
 2. CertainTeed Corp.
 3. Georgia-Pacific Gypsum LLC.
 4. Lafarge North America Inc.
 5. National Gypsum Company.
 6. USG Corporation.
- B. Gypsum Wallboard: ASTM C 1396/C 1396M.
1. Thickness: 5/8 inch (12.7 mm).
 2. Long Edges: Tapered.
- C. Gypsum Board, Type X: ASTM C 1396/C 1396M.
1. Thickness: 5/8 inch (15.9 mm).
 2. Long Edges: Tapered.
- D. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
1. Thickness: 1/4 inch (6.4 mm).
 2. Long Edges: Tapered.
- E. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
1. Thickness: 5/8 inch (12.7 mm).
 2. Long Edges: Tapered.
- F. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
1. Core: As indicated, 5/8 inch (15.9 mm), Type X, unless otherwise noted.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D 3273, score of 10.

2.4 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

- A. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, 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. American Gypsum.
 - b. CertainTeed Corp.

- c. Georgia-Pacific Gypsum LLC.
 - d. Lafarge North America Inc.
 - e. National Gypsum Company.
 - f. PABCO Gypsum.
 - g. Temple-Inland.
 - h. USG Corporation.
2. Core: As indicated, 5/8 inch (15.9 mm), Type X, unless otherwise noted.
- B. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.
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. CertainTeed Corp.; GlasRoc Sheathing.
 - b. Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
 - c. National Gypsum Company; Gold Bond, e(2)XP.
 - d. USG Corporation; Securock Glass Mat Sheathing.
 2. Core: As indicated, 5/8 inch (15.9 mm), Type X, unless otherwise noted.

2.5 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
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. CertainTeed Corp.; GlasRoc Tile Backer.
 - b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
 2. Core: As indicated on Drawings, 5/8 inch (15.9 mm), Type X, unless otherwise noted.
 3. Mold Resistance: ASTM D 3273, score of 10.
- B. Water-Resistant Gypsum Backing Board: ASTM C 1396/C 1396M, 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. American Gypsum.
 - b. CertainTeed Corp.
 - c. Georgia-Pacific Gypsum LLC.
 - d. Lafarge North America Inc.
 - e. PABCO Gypsum.
 - f. Temple-Inland.
 - g. USG Corporation.
 2. Core: As indicated on Drawings 5/8 inch (15.9 mm), Type X, unless otherwise noted.

2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
1. Material: Galvanized steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
 2. Shapes:
 - a. Corner bead.
 - b. Bullnose bead.
 - c. Casing bead / LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.
- B. Exterior Trim: ASTM C 1047.
1. Material: Hot-dip galvanized steel sheet.
 2. Shapes:
 - a. Corner bead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
1. Interior Gypsum Board: Paper.
 2. Exterior Gypsum Soffit Board: Paper.
 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
 4. Tile 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 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 drying-type, all-purpose compound.
 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 5. Skim Coat: For final coat of Level 5 finish, use 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 Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

E. Joint Compound for Tile 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.
3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.8 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. 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.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
2. Recycled Content of Blankets: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent.

E. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

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. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
 - b. Grabber Construction Products; Acoustical Sealant GSC.
 - c. Pecora Corporation; AC-20 FTR.
 - d. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
 - e. USG Corporation; SHEETROCK Acoustical Sealant.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."
- G. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- 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. Control joints to be installed minimum 24'-0" o.c. until noted otherwise.
- 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, except floors. 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. Comply with ASTM C 919 and with manufacturer's written recommendations 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. Wallboard Type: As indicated on Drawings.
- 2. Type X: As indicated on Drawings.
- 3. Flexible Type: Apply in double layer at curved assemblies.
- 4. Ceiling Type: As indicated on Drawings.
- 5. Foil-Backed Type: As indicated on Drawings.
- 6. Abuse-Resistant Type: As indicated on Drawings.
- 7. Moisture- and Mold-Resistant Type: As indicated on Drawings.
- 8. Type X: Where required for specific fire-resistance-rated assembly indicated.
- 9. Glass-Mat Interior Type: As indicated on Drawings.
- 10. Skim-Coated Type: As indicated on Drawings.

- 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 vertically (parallel 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-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-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 layers and face layers separately to supports with screws.
- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING TILE BACKING PANELS

- A. Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. 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 areas, and where indicated.
- C. Where tile 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.
 2. Bullnose Bead: Use where indicated.
 3. LC-Bead: Use at exposed panel edges.
 4. L-Bead: Use where indicated.
 5. U-Bead: Use at exposed panel edges.
 6. Curved-Edge Cornerbead: Use at curved openings.
- D. Exterior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners.
 2. LC-Bead: Use at exposed panel edges.
- E. Aluminum Trim: Install in locations indicated on Drawings.

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, rounded or beveled edges, 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: Where indicated on Drawings.
 - 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in other Division 09 Sections.
 - 5. Level 5: Where indicated on Drawings.
 - a. Primer and its application to surfaces are specified in other Division 09 Sections.
- E. 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 09 29 00

SECTION 09 51 10 - ACOUSTICAL TILE CEILINGS

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. Acoustical tiles for ceilings.
2. Concealed suspension systems.

B. Related Requirements:

1. Division 09 Section "Gypsum Board".
2. Division 21-28 for light fixtures, sprinklers and air distribution components.

- C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
2. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
3. Laboratory Test Reports for Credit EQ 4: For ceiling systems, adhesives and sealants, documentation indicating that products 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. Samples: For each exposed product and for each color and texture specified, **6-inches-** (150-mm-) in size.

- D. Samples for Initial Selection: For components with factory-applied color finishes.
- E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
 - 2. Concealed Suspension-System Members: 6-inch- (150-mm-) long Sample of each type.
 - 3. Exposed Moldings and Trim: Set of 6-inch- (150-mm-) long Samples of each type and color.

1.5 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-system members.
 - 2. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 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. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).
- B. Qualification Data: For testing agency.
- C. Product Test Reports: For each acoustical tile ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Evaluation Reports: For each acoustical tile ceiling suspension system and anchor and fastener type, from ICC-ES.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 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. Acoustical Ceiling Units: Full-size tiles equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each concealed grid and exposed component equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to the National Voluntary Laboratory Accreditation Program (NVLAP) for testing indicated.
- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of typical ceiling area as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, suspension-system components, and accessories to Project site in original, unopened packages 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 tiles, permit them to reach room temperature and stabilized moisture content.
- C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, 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 the Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, suspension-system components, and accessories to Project site in original, unopened packages 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 tiles, permit them to reach room temperature and stabilized moisture content.
- C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

2.2 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, 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 tile ceiling installation.
 2. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 ACOUSTICAL TILES, GENERAL

- A. Low-Emitting Materials: Acoustical tile ceilings 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. Source Limitations:
1. Acoustical Ceiling Tile: Obtain each type from single source from single manufacturer.
 2. Suspension System: Obtain each type from single source from single manufacturer.
- C. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension system from single source from single manufacturer.
- D. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.
- E. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.
1. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.4 ACOUSTICAL TILES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following. If not indicated, provide Tundra #303 tegular 24" x 24" x 5/8" thick at 1.1 lbs/sf, as manufactured by Armstrong World Industries:
1. BPB Celotex.

2. CertainTeed Corp.
3. USG Interiors, Inc.; Subsidiary of USG Corporation.

- B. Color: As indicated on Drawings, if not indicated on drawings, provide white.
- C. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.5 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M as applicable to the type of suspension system required for the type of ceiling units indicated. Coordinate with other work supported by or penetrating through the ceilings, including light fixtures, HVAC equipment, and partition system (if any).
- B. 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. 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 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so 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 provide not less than 12 gauge diameter wire.
- D. Hanger Rods: 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/A 653M, **G90 (Z275)** coating designation; with bolted connections and **5/16-inch- (8-mm-)** diameter bolts.

2.6 METAL SUSPENSION SYSTEM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide same as acoustical ceiling manufacturer or comparable product by one of the following:
1. Chicago Metallic Corporation.
 2. Donn Products.
 3. National Rolling Mills Company.
 4. USG Interiors, Inc.; Subsidiary of USG Corporation.

- B. Type of System: Either Direct-Hung, Double-Web Suspension System or Indirect Hung Suspension System (as Contractor's option): Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30 (Z90) coating designation.
1. Structural Classification: Intermediate-duty system.
 2. Indirect-Hung Suspension System, conform to the following:
 - a. Carrying Channels: 1-1/2" steel channels, hot-rolled or cold-rolled, not less than 0.475 lbs. per lin. Ft.
- C. Concealed Suspension System: Manufacturer's standard galvanized steel system of runners, cross runners, splines and accessories.
1. Access: Manufacturer's standard total access system, either up-acting or down-acting (each 12 x 24 unit independently removable.)
 2. Provide access units for up to a maximum of 25% of the total ceiling area.
- D. Exposed Suspension System: Manufacturer's standard exposed runners, cross-runners and accessories, of the types and profiles indicated, with exposed cross-runners coped to lay flush with main runners.
1. Finish of Exposed Members: Provide uniform factory-applied finish on exposed surfaces of ceiling suspension system including moldings, trim and accessories.
 2. Finish: Manufacturer's standard baked enamel finish, white unless otherwise selected by Architect.

2.7 METAL EDGE MOLDINGS AND TRIM

- A. Edge Moldings: Provide manufacturer standard angle moldings; in finish to match exposed system. Provide manufacturer's standard angle moldings in finish to match exposed system.

2.8 ACOUSTICAL SEALANT

- A. Acoustical Sealant: A heavy-bodied, non-shrinking, non-drying, non-sag, grade mastic compound intended for interior sealing of concealed construction joints.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION WORK

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Verify that layout of hangers will not interfere with other work; make adjustments in layout as necessary.
- E. Do not begin ceiling installation until services above ceiling are complete except for final trim.
- F. Notify Architect of unsatisfactory conditions before proceeding.
- G. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.
- H. Locate system on room axis according to reflected ceiling plan.

3.2 INSTALLATION OF CEILING TILES

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Install acoustical panels in accordance with manufacturer's written instructions.
- C. Lay panels flat into the tee grid. Scribe and cut panels for accurate fit at perimeter and around penetrations.
- D. Hold tile field in compression when performing cuts.
- E. Install acoustical panels after above-ceiling work is complete. Install panels level, in uniform plane, and free from warp, twists, and dents.
- F. Installation Tolerance: Maximum variation from flat and level surface is 1:360.

3.3 INSTALLATION OF SUSPENSION SYSTEM

- A. General:
 - 1. Conform to the requirements of CISCA (AC) – Acoustical Ceilings: Use and Practice.
 - 2. Install in accordance with manufacturer's instructions and ASTM C 636 and ASTM E 580.
 - 3. Attach hangers to structural members. Do not support ceilings directly from permanent metal forms or steel floor or roof deck.
 - 4. Space hangers not more than 48 inches o.c. in both directions.
 - 5. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
 - 6. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

7. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently. Do not eccentrically load system or induce rotation of runners.
 8. Perimeter Trim: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
- 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[**and, if permitted with fire-resistance-rated ceilings,**] 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. Connect hangers directly either to structures 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.
 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 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.
 6. 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.
 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 (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.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. 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.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. 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, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Arrange directionally patterned acoustical tiles as follows:
 - 1. As indicated on reflected ceiling plans.
 - 2. Install tiles with pattern running in one direction parallel to long or short axis of space.
 - 3. Install tiles in a basket-weave pattern.
- G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
 - 1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
 - 2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches (305 mm) o.c.
 - 3. Protect lighting fixtures and air ducts to comply with requirements indicated for the indicated fire-resistance-rated assembly design.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.
- B. Protect installed acoustical panel ceilings until completion of project.

END OF SECTION 09 51 10

SECTION 096510 - RESILIENT BASE AND ACCESSORIES

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. Resilient base.
2. Resilient stair accessories.
3. Resilient molding accessories.

B. Related Sections:

1. Division 09 Section "Resilient Sheet Flooring" for resilient sheet floor coverings.
2. Division 09 Section "Linoleum Flooring" for linoleum floor coverings.
3. Division 09 Section "Resilient Tile Flooring" for resilient floor tile.
4. Division 09 Section "Static-Control Resilient Flooring" for resilient floor coverings designed to control electrostatic discharge.
5. Division 09 Section "Resilient Athletic Flooring" for resilient floor coverings for use in athletic-activity or support areas.

1.3 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives, documentation indicating that products 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. Samples for Initial Selection: For each type of product indicated.

- D. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.

- E. Product Schedule: For resilient products.[**Use same designations indicated on Drawings.**]

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. Furnish not less than [**10 linear feet (3 linear m)**] <Insert length> for every [**500 linear feet (150 linear m)**] <Insert length> or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

- 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. Mockups: Provide resilient products with mockups specified in other Sections.

1.6 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 (10 deg C)** or more than **90 deg F (32 deg C)**.

1.7 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than [**70 deg F (21 deg C)**] <Insert temperature> or more than [**95 deg F (35 deg C)**] <Insert temperature>, 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. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than [**55 deg F (13 deg C)**] <Insert temperature> or more than [**95 deg F (35 deg C)**] <Insert temperature>.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE <Insert drawing designation>

A. Resilient Base:

1. Manufacturers: Subject to compliance with requirements, **[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. Allstate Rubber Corp.; Stoler Industries.
 - b. Armstrong World Industries, Inc.
 - c. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
 - d. Endura Rubber Flooring; Division of Burke Industries, Inc.
 - e. Estrie Products International; American Biltrite (Canada) Ltd.
 - f. Flexco, Inc.
 - g. Johnsonite.
 - h. Mondo Rubber International, Inc.
 - i. Musson, R. C. Rubber Co.
 - j. Nora Rubber Flooring; Freudenberg Building Systems, Inc.
 - k. PRF USA, Inc.
 - l. Roppe Corporation, USA.
 - m. VPI, LLC; Floor Products Division.
 - n. **<Insert manufacturer's name>**.

B. Resilient Base Standard: ASTM F 1861.

1. Material Requirement: **[Type TV (vinyl, thermoplastic)] [Type TS (rubber, vulcanized thermoset)] [Type TP (rubber, thermoplastic)] [Type TS (rubber, vulcanized thermoset) or Type TP (rubber, thermoplastic)].**
2. Manufacturing Method: **[Group I (solid, homogeneous)] [Group II (layered)] [Group I (solid, homogeneous) or Group II (layered)].**
3. Style: **[Cove (base with toe)] [Straight (flat or toeless)] [Butt to (fit-to-floor)] <Insert special style>**.

C. Minimum Thickness: **[0.125 inch (3.2 mm)] [0.080 inch (2.0 mm)] <Insert thickness>**.D. Height: **[2-1/2 inches (64 mm)] [4 inches (102 mm)] [6 inches (152 mm)] [As indicated on Drawings].**E. Lengths: **[Cut lengths, 48 inches (1219 mm) long] [Coils in manufacturer's standard length] [Cut lengths 48 inches (1219 mm) long or coils in manufacturer's standard length].**F. Outside Corners: **[Job formed] [Preformed] [Job formed or preformed].**G. Inside Corners: **[Job formed] [Preformed] [Job formed or preformed].**H. Finish: **[Satin] [Matte] [Low luster] [As selected by Architect from manufacturer's full range].**

- I. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].

2.2 RESILIENT STAIR ACCESSORIES <Insert drawing designation>

A. Resilient Stair Treads:

1. Manufacturers: Subject to compliance with requirements, [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. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
- b. Endura Rubber Flooring; Division of Burke Industries, Inc.
- c. Estrie Products International; American Biltrite (Canada) Ltd.
- d. Flexco, Inc.
- e. Johnsonite.
- f. Mondo Rubber International, Inc.
- g. Musson, R. C. Rubber Co.
- h. Nora Rubber Flooring; Freudenberg Building Systems, Inc.
- i. PRF USA, Inc.
- j. R.C.A. Rubber Company (The).
- k. Roppe Corporation, USA.
- l. VPI, LLC; Floor Products Division.
- m. <Insert manufacturer's name>.

B. Resilient Stair Treads Standard: ASTM F 2169.

1. Material Requirement: [Type TV (vinyl, thermoplastic)] [Type TS (rubber, vulcanized thermoset)] [Type TP (rubber, thermoplastic)] [Type TS (rubber, vulcanized thermoset) or Type TP (rubber, thermoplastic)].
2. Surface Design:
 - a. Class 1, Smooth (flat).
 - b. Class 2, Pattern: [Raised-disc design] [Raised-square design] [Raised-chevron design] [Raised-diamond design] [Raised-rib design] [Raised-rib design with abrasive strips] <Insert pattern>.
3. Manufacturing Method: [Group 1, tread with embedded abrasive strips] [Group 2, tread with contrasting color for the visually impaired].

C. Nosing Style: [Square, adjustable to cover angles between 60 and 90 degrees] [Square] [Round].

D. Nosing Height: [1-1/2 inches (38 mm)] [2 inches (51 mm)] [2-3/16 inches (56 mm)] <Insert dimension>.

E. Thickness: [1/4 inch (6 mm) and tapered to back edge] <Insert thickness>.

- F. Size: Lengths and depths to fit each stair tread in **[one piece]** **[one piece or, for treads exceeding maximum lengths manufactured, in equal-length units]**.
- G. Risers: Smooth, flat, **[coved-toe, 7 inches (178 mm) high by length matching treads]** **[toeless, height and length to cover risers]**; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
1. Thickness: **[0.125 inch (3.2 mm)]** **[0.080 inch (2.0 mm)]** **<Insert thickness>**.
- H. Stringers: Of same thickness as risers, height and length after cutting to fit risers and treads and to cover stair stringers; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
- I. Colors and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.
- 2.3 RESILIENT MOLDING ACCESSORY **<Insert drawing designation>**
- A. Resilient Molding Accessory:
1. Manufacturers: Subject to compliance with requirements, **[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. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
- b. Flexco, Inc.
- c. Johnsonite.
- d. R.C.A. Rubber Company (The).
- e. Roppe Corporation, USA.
- f. VPI, LLC; Floor Products Division.
- g. **<Insert manufacturer's name>**.
- B. Description: **[Cap for cove carpet]** **[Cap for cove resilient floor covering]** **[Carpet bar for tackless installations]** **[Carpet edge for glue-down applications]** **[Nosing for carpet]** **[Nosing for resilient floor covering]** **[Reducer strip for resilient floor covering]** **[Joiner for tile and carpet]** **[Transition strips]** **<Insert description>**.
- C. Material: **[Vinyl]** **[Rubber]**.
- D. Profile and Dimensions: **[As indicated]** **<Insert profile and dimensions>**.
- E. Colors and Patterns: **[As indicated by manufacturer's designations]** **[Match Architect's sample]** **[As selected by Architect from full range of industry colors]**.

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 manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24)[, **except that adhesive for rubber stair treads shall have a VOC content of 60 g/L or less**].
 - 2. Adhesives 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. Stair-Tread-Nose Filler: Two-part epoxy compound recommended by resilient tread manufacturer to fill nosing substrates that do not conform to tread contours.
- D. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.
- E. Floor Polish: Provide protective liquid floor polish products as recommended by resilient stair tread manufacturer.

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.
- 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 adhesion of resilient products.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Treads and Accessories: 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 manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
4. Moisture Testing: Perform tests recommended by manufacturer[**and as follows**]. Proceed with installation only after substrates pass testing.
 - a. Perform 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)**] <Insert emission> in 24 hours.
 - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum [**75 percent**] <Insert acceptable percentage> relative humidity level measurement.
- 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 resilient products until they are same temperature as the space where they are to be installed.
 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

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 practicable 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 masonry surfaces or other similar 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. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.
2. Inside Corners: Use straight pieces of maximum lengths possible.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. 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.
- C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of [**carpet**] [**resilient floor covering**] that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of 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 surfaces thoroughly.
 3. Damp-mop 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. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.
 1. Apply [**one**] [**two**] [**three**] <Insert requirement> coat(s).
- E. Cover resilient products until Substantial Completion.

END OF SECTION 096510

SECTION 096516 - RESILIENT SHEET FLOORING

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. Vinyl sheet floor covering, **[with] [and] [without]** backing.
2. Rubber sheet floor covering, **[with] [and] [without]** backing.

B. Related Sections:

1. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.
2. Division 09 Section "Linoleum Flooring" for linoleum sheet floor coverings.
3. Division 09 Section "Resilient Tile Flooring" for resilient floor tile.
4. Division 09 Section "Static-Control Resilient Flooring" for resilient floor coverings designed to control electrostatic discharge.
5. Division 09 Section "Resilient Athletic Flooring" for resilient floor coverings for use in athletic-activity or support areas.

1.3 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For **[adhesives] [and] [chemical-bonding compounds]**, documentation including printed statement of VOC content.
2. Product Data for Credit IEQ 4.3: For adhesives **[and chemical-bonding compounds]**, documentation including printed statement of VOC content.
3. Product Data for Credit IEQ 4.3: For resilient sheet flooring, documentation from an independent testing agency indicating compliance with the FloorScore Standard.
4. Laboratory Test Reports for Credit IEQ 4: For adhesives **[flooring system] [and] [chemical-bonding compounds]**, documentation indicating that products 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. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

1. Show details of special patterns.
 - D. Samples for Initial Selection: For each type of floor covering indicated.
 - E. Samples for Verification: In manufacturer's standard size, but not less than [6-by-9-inch (150-by-230-mm)] <Insert size> sections of each different color and pattern of floor covering required.
 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than [9 inches (230 mm)] <Insert dimension> long, of each color required.
 - F. Seam Samples: For seamless-installation technique indicated and for each floor covering product, color, and pattern required; with seam running lengthwise and in center of [6-by-9-inch (150-by-230-mm)] <Insert size> Sample applied to a rigid backing and prepared by Installer for this Project.
 - G. Product Schedule: For floor coverings. [Use same designations indicated on Drawings.]
- 1.4 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For qualified Installer.
- 1.5 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For each type of floor covering to include in 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. Floor Covering: Furnish quantity not less than [10 linear feet (3 linear m)] <Insert length> for every [500 linear feet (150 linear m)] <Insert length> or fraction thereof, in roll form and in full roll width for each color, pattern, and type of floor covering installed.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation [and seaming method] indicated.
 1. Engage an installer who employs workers for this Project who are trained or certified by floor covering manufacturer for installation techniques required.
 - B. 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.

- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups for floor coverings including[**resilient base and**] accessories.
 - a. Size: Minimum **100 sq. ft. (9.3 sq. m)** for each type, color and pattern [**in locations indicated**] [**in locations directed by Architect**] **<Insert location requirements>**.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store floor coverings 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 (10 deg C)** or more than **90 deg F (32 deg C)**. Store rolls upright.

1.9 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than **[70 deg F (21 deg C)] <Insert temperature>** or more than **[85 deg F (29 deg C)] <Insert temperature>**, in spaces to receive floor coverings during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than **[55 deg F (13 deg C)] <Insert temperature>** or more than **[95 deg F (35 deg C)] <Insert temperature>**.
- C. Close spaces to traffic during floor covering installation.
- D. Close spaces to traffic for 48 hours after floor covering installation.
- E. Install floor coverings after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. FloorScore Compliance: Resilient sheet flooring shall comply with requirements of FloorScore Standard.
- B. Low-Emitting Materials: Flooring system 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 VINYL SHEET FLOOR COVERING <Insert drawing designation>

- A. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
1. Altro Group; <Insert product name or designation>.
 2. Armstrong World Industries, Inc.; <Insert product name or designation>.
 3. Congoleum Corporation; <Insert product name or designation>.
 4. DzynSpec, Division of Matsinc.; <Insert product name or designation>.
 5. Forbo Flooring, Inc.; <Insert product name or designation>.
 6. Gerflor, Architectural Floor Systems, Inc.; <Insert product name or designation>.
 7. Lonseal, Inc.; <Insert product name or designation>.
 8. Mannington Mills, Inc.; <Insert product name or designation>.
 9. Polyflor, Ltd., Distributed by Gerbert Limited; <Insert product name or designation>.
 10. Tarkett, Inc.; <Insert product name or designation>.
 11. TOLI International; <Insert product name or designation>.
 12. <Insert manufacturer's name; product name or designation>.
- B. Unbacked Vinyl Sheet Floor Covering: ASTM F 1913, [0.080 inch (2.0 mm)] <Insert dimension> thick.
- C. Vinyl Sheet Floor Covering with Backing: ASTM F 1303.
1. Type (Binder Content): [Type I, minimum binder content of 90 percent] [Type II, minimum binder content of 34 percent].
 2. Wear-Layer Thickness: Grade 1.
 3. Overall Thickness: [As standard with manufacturer] <Insert thickness>.
 4. Interlayer Material: [Foamed plastic] [None].
 5. Backing Class: [Class A (fibrous)] [Class B (nonfoamed plastic)] [Class C (foamed plastic)].
- D. Wearing Surface: [Smooth] [Embossed] [Smooth with embedded abrasives] [Embossed with embedded abrasives].
- E. Sheet Width: [As standard with manufacturer] [4.9 feet (1.5 m)] [6 feet (1.8 m)] [6.5 feet (1.98 m)] [6.6 feet (2.0 m)] [9 feet (2.7 m)] [12 feet (3.6 m)].
- F. Seaming Method: [Heat welded] [Chemically bonded] [Standard] <Insert requirements>.
- G. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].

2.3 RUBBER SHEET FLOOR COVERING <Insert drawing designation>

- A. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
1. Estrie Products International, American Biltrite (Canada) Ltd.; <Insert product name or designation>.
 2. Flexco; <Insert product name or designation>.
 3. Johnsonite; <Insert product name or designation>.

4. Mondo Rubber International, Inc.; <Insert product name or designation>.
 5. Nora Rubber Flooring, Freudenberg Building Systems, Inc.; <Insert product name or designation>.
 6. PRF USA Inc.; <Insert product name or designation>.
 7. R.C.A. Rubber Company (The); <Insert product name or designation>.
 8. <Insert manufacturer's name; product name or designation>.
- B. Unbacked Rubber Sheet Floor Covering: ASTM F 1859.
1. Type: [Type I (homogeneous rubber sheet)] [Type II (layered rubber sheet)].
 2. Thickness: [As standard with manufacturer] <Insert thickness>.
- C. Rubber Sheet Floor Covering with Backing: ASTM F 1860.
1. Type: [Type I, homogeneous rubber sheet with backing] [Type II, layered rubber sheet with backing].
 2. Wear-Layer Thickness: [As standard with manufacturer] <Insert thickness>.
 3. Overall Thickness: [As standard with manufacturer] <Insert thickness>.
 4. Interlayer Material: [As standard with manufacturer] [None].
 5. Backing Type: [Fibrous)] [Foamed rubber].
- D. Hardness: [Not less than required by ASTM F 1859] [Not less than required by ASTM F 1860] [Manufacturer's standard hardness, measured using Shore, Type A durometer per ASTM D 2240].
- E. Wearing Surface: [Smooth] [Textured] [Molded pattern].
1. Molded-Pattern Figure: [Raised discs] [Raised squares] <Insert pattern>.
- F. Sheet Width: [As standard with manufacturer] [4.9 feet (1.5 m)] [6 feet (1.8 m)] [6.5 feet (1.98 m)] [6.6 feet (2.0 m)] [9 feet (2.7 m)] [12 feet (3.6 m)].
- G. Seaming Method: [Heat welded] [Chemically bonded] [Standard] <Insert requirements>.
- H. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].

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 manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.
1. Adhesives shall have a VOC content of not more than [50] [60] <Insert value> g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesives 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. 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 to contrast with floor covering] [Match floor covering] <Insert color>**.
 2. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.
 - a. VOC Content: Not more than 510 g/L. when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Bonding compound 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."
- D. Integral-Flash-Cove-Base Accessories:
1. Cove Strip: **1-inch (25-mm)** radius provided or approved by manufacturer.
 2. Cap Strip: **[Square metal, vinyl, or rubber cap] [Tapered vinyl cap] <Insert requirements>** provided or approved by manufacturer.
 3. Corners: Metal inside and outside corners and end stops provided or approved by manufacturer.
- E. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

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.
- 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 adhesion of floor coverings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.
- 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 manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

4. Moisture Testing: Perform tests recommended by manufacturer[**and as follows**]. Proceed with installation only after substrates pass testing.
 - a. Perform 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)**] <Insert emission> in 24 hours.
 - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum [**75 percent**] <Insert acceptable percentage> relative humidity level measurement.
- 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 floor coverings until they are same temperature as space where they are to be installed.
 1. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.3 FLOOR COVERING INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor coverings.
- B. Unroll floor coverings and allow them to stabilize before cutting and fitting.
- C. Lay out floor coverings as follows:
 1. Maintain uniformity of floor covering direction.
 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least **6 inches (152 mm)** away from parallel joints in floor covering substrates.
 3. Match edges of floor coverings for color shading at seams.
 4. Avoid cross seams.
- D. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.
- E. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
- F. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor coverings on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of floor coverings installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor coverings 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 use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
 - 2. Chemically-Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly-fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.

- J. Integral-Flash-Cove Base: Cove floor coverings **[6 inches (152 mm)] [dimension indicated]** <Insert dimension> up vertical surfaces. Support floor coverings at horizontal and vertical junction by cove strip. Butt at top against cap strip.
 - 1. Install metal corners at inside and outside corners.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
- B. Perform the following operations immediately after completing floor covering installation:
 - 1. Remove adhesive and other blemishes from floor covering surfaces.
 - 2. Sweep and vacuum floor coverings thoroughly.
 - 3. Damp-mop floor coverings to remove marks and soil.
- C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor covering before applying liquid floor polish.
 - 1. Apply **[one] [two] [three]** <Insert requirement> coat(s).
- E. Cover floor coverings until Substantial Completion.

END OF SECTION 096516

SECTION 096519 - RESILIENT TILE FLOORING

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. Solid vinyl floor tile.
2. Rubber floor tile.
3. Vinyl composition floor tile.
4. Resilient terrazzo floor tile.

B. Related Sections:

1. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.
2. Division 09 Section "Resilient Sheet Flooring" for resilient sheet floor coverings.
3. Division 09 Section "Linoleum Flooring" for linoleum floor coverings.
4. Division 09 Section "Static-Control Resilient Flooring" for resilient floor coverings designed to control electrostatic discharge.
5. Division 09 Section "Resilient Athletic Flooring" for resilient floor coverings for use in athletic-activity or support areas.

1.3 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For **[adhesives] [sealants] [and] [chemical-bonding compounds]**, documentation including printed statement of VOC content.
2. Product Data for Credit IEQ 4.3: For adhesives **[and chemical-bonding compounds]**, documentation including printed statement of VOC content.
3. Product Data for Credit IEQ 4.3: For resilient tile flooring, documentation from an independent testing agency indicating compliance with the FloorScore Standard.
4. Laboratory Test Reports for Credit IEQ 4: For **[flooring system] [adhesives] [sealants] [and] [chemical-bonding compounds]**, documentation indicating that products 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. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

1. Show details of special patterns.
 - D. Samples for Initial Selection: For each type of floor tile indicated.
 - E. Samples for Verification: Full-size units of each color and pattern of floor tile required.
 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than [9 inches (230 mm)] <Insert dimension> long, of each color required.
 - F. Seam Samples: For seamless-installation technique indicated and for each flooring product, color, and pattern required; with seam running lengthwise and in center of [6-by-9-inch (150-by-230-mm)] <Insert size> Sample applied to a rigid backing and prepared by Installer for this Project.
 - G. Product Schedule: For floor tile. [Use same designations indicated on Drawings.]
- 1.4 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For qualified Installer.
- 1.5 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.
- 1.6 MATERIALS MAINTENANCE 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 1 box for every [50] <Insert number> boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
- 1.7 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 manufacturer for installation techniques required.
 - B. 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.
 - C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mockups for floor tile including[resilient base and] accessories.

- a. Size: Minimum **100 sq. ft. (9.3 sq. m)** for each type, color, and pattern **[in locations indicated] [in locations directed by Architect] <Insert location requirements>**.

1.8 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 (10 deg C)** or more than **90 deg F (32 deg C)**. Store floor tiles on flat surfaces.

1.9 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than **[70 deg F (21 deg C)] <Insert temperature>** or more than **[95 deg F (35 deg C)] <Insert temperature>**, in spaces to receive floor tile during the following time periods:
 1. 48 hours before installation.
 2. During installation.
 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than **[55 deg F (13 deg C)] <Insert temperature>** or more than **[95 deg F (35 deg C)] <Insert temperature>**.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. FloorScore Compliance: Resilient tile flooring shall comply with requirements of FloorScore Standard.
- B. Low-Emitting Materials: Flooring system 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 SOLID VINYL FLOOR TILE <Insert drawing designation>

- A. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 1. Altro Group; **<Insert product name or designation>**.
 2. Amtico Studio (The), Amtico International Inc.; **<Insert product name or designation>**.
 3. Armstrong World Industries, Inc.; **<Insert product name or designation>**.

4. Burke Mercer Flooring Products, Division of Burke Industries Inc.; <Insert product name or designation>.
 5. Estrie Products International, American Biltrite (Canada) Ltd.; <Insert product name or designation>.
 6. Flexco; <Insert product name or designation>.
 7. Gemtec Inc.; <Insert product name or designation>.
 8. Gerflor, Architectural Floor Systems, Inc.; <Insert product name or designation>.
 9. Johnsonite; <Insert product name or designation>.
 10. Polyflor, Ltd., Distributed by Gerbert Limited; <Insert product name or designation>.
 11. Roppe Corporation, USA; <Insert product name or designation>.
 12. Tarkett, Inc.; <Insert product name or designation>.
 13. TOLI International; <Insert product name or designation>.
 14. VPI, LLC, Floor Products Division; <Insert product name or designation>.
 15. <Insert manufacturer's name; product name or designation>.
- B. Tile Standard: ASTM F 1700.
1. Class: [As indicated by product designations] [Class I, monolithic vinyl tile] [Class II, surface-decorated vinyl tile] [Class III, printed film vinyl tile].
 2. Type: [Type A, smooth surface] [Type B, embossed surface].
- C. Thickness: [0.080 inch (2.0 mm)] [0.100 inch (2.5 mm)] [0.120 inch (3.0 mm)] [0.125 inch (3.2 mm)] <Insert thickness>.
- D. Size: [12 by 12 inches (305 by 305 mm)] [18 by 18 inches (457 by 457 mm)] [24 by 24 inches (610 by 610 mm)] [36 by 36 inches (914 by 914 mm)] [3 by 36 inches (76 by 914 mm)] <Insert size>.
- E. Seaming Method: [Heat welded] [Chemically bonded] [Standard] <Insert requirements>.
- F. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
- 2.3 RUBBER FLOOR TILE <Insert drawing designation>
- A. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
1. Burke Mercer Flooring Products, Division of Burke Industries Inc.; <Insert product name or designation>.
 2. Endura Rubber Flooring, a division of Burke Industries Inc.; <Insert product name or designation>.
 3. Estrie Products International, American Biltrite (Canada) Ltd.; <Insert product name or designation>.
 4. Flexco; <Insert product name or designation>.
 5. Johnsonite; <Insert product name or designation>.
 6. Mondo Rubber International, Inc.; <Insert product name or designation>.
 7. Nora Rubber Flooring, Freudenberg Building Systems, Inc.; <Insert product name or designation>.
 8. PRF USA Inc.; <Insert product name or designation>.
 9. R.C.A. Rubber Company (The); <Insert product name or designation>.
 10. Roppe Corporation, USA; <Insert product name or designation>.
 11. <Insert manufacturer's name; product name or designation>.

- B. Tile Standard: ASTM F 1344, [Class I-A, homogeneous rubber tile, solid color] [Class I-B, homogeneous rubber tile, through mottled] [Class II-A, laminated rubber tile, solid-color wear layer] [Class II-B, laminated rubber tile, mottled wear layer].
- C. Hardness: [Not less than 85 as required by ASTM F 1344, measured using Shore, Type A durometer per ASTM D 2240] [Manufacturer's standard hardness].
- D. Wearing Surface: [Smooth] [Textured] [Molded pattern].
 - 1. Molded-Pattern Figure: [Raised discs] [Raised squares] <Insert pattern>.
- E. Thickness: [0.125 inch (3.2 mm)] <Insert thickness>.
- F. Size: [12 by 12 inches (305 by 305 mm)] [24 by 24 inches (610 by 610 mm)] <Insert size>.
- G. Seaming Method: [Heat welded] [Chemically bonded] [Standard] <Insert requirements>.
- H. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].

2.4 VINYL COMPOSITION FLOOR TILE <Insert drawing designation>

- A. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. AB ColorPlus, American Biltrite (Canada) Ltd.; <Insert product name or designation>.
 - 2. Armstrong World Industries, Inc.; <Insert product name or designation>.
 - 3. Congoleum Corporation; <Insert product name or designation>.
 - 4. Mannington Mills, Inc.; <Insert product name or designation>.
 - 5. Tarkett, Inc.; <Insert product name or designation>.
 - 6. Vinylasa Tile, Distributed by American Tile Inc.; <Insert product name or designation>.
 - 7. <Insert manufacturer's name; product name or designation>.
- B. Tile Standard: ASTM F 1066, [Class 1, solid-color tile] [Class 2, through-pattern tile] [Class 3, surface-pattern tile].
- C. Wearing Surface: [Smooth] [Embossed].
- D. Thickness: [0.125 inch (3.2 mm)] <Insert thickness>.
- E. Size: 12 by 12 inches (305 by 305 mm).
- F. Colors and Patterns: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].

2.5 RESILIENT TERRAZZO FLOOR TILE <Insert drawing designation>

- A. Resilient Terrazzo Floor Tile: Marble or granite chips embedded in flexible, thermoset-polyester-resin matrix; electrically nonconductive and chemical, oil, and corrosion resistive, with smooth wearing surface and manufacturer's standard factory-applied, protective urethane coating.

1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Fritz Industries; **<Insert product name or designation>**.
 - b. **<Insert manufacturer's name; product name or designation>**.
 - B. Thickness: **[1/8 inch (3.0 mm)] [3/16 inch (4.8 mm)]**.
 - C. Size: **12 by 12 inches (305 by 305 mm)**.
 - D. Performance Characteristics:
 1. Compressive Strength: **2900 to 5000 psi (20 to 34.5 MPa)**, ASTM C 109/C 109M or ASTM D 695.
 2. Abrasion Resistance: Maximum 0.0196 cubic centimeters volume loss, ASTM F 510, Taber abrader, S-39 wheels, at 500 cycles with 1000-gram load.
 3. Static Load Limit: **0.0007-inch (0.0177-mm)** maximum indentation, ASTM F 970 at **125 lb (57 kg)**.
 4. Resin Matrix Hardness: Not less than 78, as measured using Shore, Type D durometer per ASTM D 2240.
 - E. Colors and Patterns: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors]**.
- 2.6 INSTALLATION MATERIALS
- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
 - B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.
 1. Adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
 - b. Rubber Floor Adhesives: Not more than 60 g/L.
 - c. Terrazzo Floor Tile Adhesives: Not more than **[65] <Insert value>** g/L.
 2. Adhesives 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. 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 to contrast with floor tile] [Match floor tile] <Insert color>**.
 2. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.

- a. Chemical-bonding compound shall have a VOC content of [350] [510] <Insert value> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Chemical-bonding compound 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."
- D. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.
- E. Joint Sealant for Resilient Terrazzo Floor Tile: Silicone sealant of type and grade as recommended in writing by manufacturer to suit resilient terrazzo floor tile.
1. Sealant shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 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."
 3. Joint-Sealant Color: [White] [As selected by Architect from manufacturer's full range to match floor tile] [Match floor tile] <Insert color>.
- F. Sealers and Finish Coats for Resilient Terrazzo Floor Tile: Premium-type products as recommended by manufacturer for resilient terrazzo floor tile.

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.
- 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 adhesion of floor tile.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- 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 manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 4. Moisture Testing: Perform tests recommended by manufacturer[and as follows]. Proceed with installation only after substrates pass testing.

- a. Perform 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)]** <Insert emission> in 24 hours.
 - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum **[75%]** <Insert acceptable percentage> relative humidity level measurement.
- C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
- D. 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.
- E. Do not install floor tiles until they are same temperature as space where they are to be installed.
1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. 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.
1. Lay tiles **[square with room axis] [at a 45-degree angle with room axis] [in pattern indicated]** <Insert requirements>.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
1. Lay tiles **[with grain running in one direction] [with grain direction alternating in adjacent tiles (basket-weave pattern)] [in pattern of colors and sizes indicated]**.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. 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, nonstaining marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

- H. Adhere floor tiles to flooring 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 floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
 - 2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on floor covering surfaces.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of 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 products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor tile surfaces before applying liquid floor polish.
 - 1. Apply **[one] [two] [three]** <Insert requirements> coat(s).
- E. Joint Sealant: Apply sealant to resilient terrazzo floor tile perimeter and around columns, at door frames, and at other joints and penetrations.
- F. Sealers and Finish Coats: Remove soil, visible adhesive, and surface blemishes from resilient terrazzo floor tile surfaces before applying liquid cleaners, sealers, and finish products.
 - 1. Sealer: Apply two base coats of liquid sealer.
 - 2. Finish: Apply **[two] [three]** <Insert requirements> coats of liquid floor finish.
- G. Cover floor tile until Substantial Completion.

END OF SECTION 096519

SECTION 096850 - TILE CARPETING

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 modular, **[fusion-bonded] [tufted] <Insert construction>** carpet tile.
- B. Related Requirements:
 - 1. Division 02 Section "Selective Structure Demolition" for removing existing floor coverings.
 - 2. Division 09 Section "**[Resilient Base and Accessories] [Resilient Tile Flooring]**" for resilient wall base and accessories installed with carpet tile.
 - 3. Division 09 Section "Sheet Carpeting."

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
 - 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.
 - d. **<Insert agenda items>**.

1.4 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 installation recommendations for each type of substrate.
- B. LEED Submittals:
 - 1. Product Data for Credit EQ 4.3:
 - a. For carpet tile, documentation indicating compliance with testing and product requirements of CRI's "Green Label Plus" program.
 - b. For installation adhesive, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit EQ 4: For carpet[**and installation adhesives**], documentation indicating that products 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. Shop Drawings: Show 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 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-** (300-mm-) long Samples.
- E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- F. Sustainability: Provide the Statement of the Achievement Level the carpet has attained for **[Bronze, 28 to 36]** **[Silver, 37 to 51]** **[Gold, 52 to 70]** points, based on specific Sustainable Attribute Performance for all product stages according to ANSI/NSF 140.
- 1.5 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
 - B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
 - C. Sample Warranty: For special warranty.
- 1.6 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.

1.7 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] <Insert number> percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the [Commercial II] [Master II] <Insert description> certification level.
- B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.
- C. 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 mockups at locations and in sizes shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104.

1.10 FIELD CONDITIONS

- A. Comply with CRI 104 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 occupancy levels 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.

1.11 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.

2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, **[dimensional stability,] [excess static discharge,] [loss of tuft bind strength,]** loss of face fiber, **<Insert failure characteristic>** and delamination.
3. Warranty Period: **[10] <Insert number>** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE **<Insert drawing designation>**

- A. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 1. **<Insert manufacturer's name; product name or designation>**.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide **[product indicated on Drawings] <Insert manufacturer's or carpet tile supplier's name; product name or designation>** or comparable product by one of the following:
 1. **<Insert manufacturers' names>**.
- C. Color: **[Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color>**.
- D. Pattern: **[Match Architect's samples] <Insert pattern>**.
- E. Fiber Content: **[100 percent nylon 6, 6] [100 percent nylon 6] [100 percent polypropylene] [100 percent wool] [80 percent wool; 20 percent nylon 6, 6] [80 percent wool; 20 percent nylon 6] <Insert percentage>**.
- F. Fiber Type: **<Insert proprietary fiber type>**.
- G. Pile Characteristic: **[Level-loop] [Cut] [Cut-and-loop] <Insert construction>** pile.
- H. Yarn Twist: **<Insert TPI (TPCM)>**.
- I. Yarn Count: **<Insert count>**.
- J. Density: **<Insert oz./cu. yd. (g/cu. cm)>**.
- K. Pile Thickness: **<Insert inches (mm)>** for finished carpet tile **[according to ASTM D 6859]**.
- L. Stitches: **<Insert stitches per inch (mm)>**.
- M. Gage: **<Insert ends per inch (mm)>**.
- N. Surface Pile Weight: **<Insert oz./sq. yd. (g/sq. m)>**.
- O. Total Weight: **<Insert oz./sq. yd. (g/sq. m)>** for finished carpet tile.
- P. Primary Backing/Backcoating: **[Manufacturer's standard composite materials] [PVC] [Fiberglass-reinforced PVC] [Fiberglass-reinforced amorphous resin] [Reinforced polyurethane composite cushion] [Reinforced polyurethane composite] [Reinforced**

thermoplastic copolymer] <Insert specific primary backing materials; consult manufacturers>.

- Q. Secondary Backing: **[Manufacturer's standard material]** <Insert specific secondary backing material>.
- R. Backing System: <Insert proprietary name>.
- S. Size: **[18 by 18 inches (457 by 457 mm)] [24 by 24 inches (610 by 610 mm)] [18 by 36 inches (457 by 914 mm)] [36 by 36 inches (914 by 914 mm)]** <Insert dimensions>.
- T. Applied Soil-Resistance Treatment: **[Manufacturer's standard material]** <Insert treatment>.
- U. Antimicrobial Treatment: **[Manufacturer's standard material]** <Insert treatment>.
- V. Performance Characteristics: As follows:
1. Appearance Retention Rating: **[Moderate traffic, 2.5] [Heavy traffic, 3.0] [Severe traffic, 3.5]** <Insert number> minimum according to ASTM D 7330.
 2. Critical Radiant Flux Classification: Not less than **[0.45 W/sq. cm] [0.22 W/sq. cm]**.
 3. Dry Breaking Strength: Not less than **100 lbf (445 N)** according to ASTM D 2646.
 4. Tuft Bind: Not less than **[3 lbf (13 N)] [5 lbf (22 N)] [6.2 lbf (28 N)] [8 lbf (36 N)] [10 lbf (45 N)]** <Insert value> according to ASTM D 1335.
 5. Delamination: Not less than **[3.5 lbf/in. (15 N/mm)] [4 lbf/in. (18 N/mm)]** <Insert value> according to ASTM D 3936.
 6. Dimensional Tolerance: Within **1/32 inch (0.8 mm)** of specified size dimensions, as determined by physical measurement.
 7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
 8. Resistance to Insects: Comply with AATCC 24.
 9. Noise Reduction Coefficient (NRC): <Insert NRC> according to ASTM C 423.
 10. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
 11. Colorfastness to Light: Not less than 4 after **[40] [60]** <Insert number> AFU (AATCC fading units) according to AATCC 16, Option E.
 12. 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.
 13. Electrostatic Propensity: Less than **[3.5] [2]** <Insert number> kV according to AATCC 134.
 14. Emissions: Provide carpet tile that complies with testing and product requirements of CRI's "Green Label Plus" program.
 15. Emissions: Provide carpet tile that complies with the 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 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 complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesives 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. Metal Edge/Transition Strips: Extruded aluminum with [mill] <Insert finish> finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum 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. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
 2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. For wood subfloors, verify the following:
1. Underlayment over subfloor complies with requirements specified in Division 06 Section "Rough Carpentry."
 2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- D. For metal subfloors, verify the following:
1. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- E. For painted subfloors, verify the following:
1. Perform bond test recommended in writing by adhesive manufacturer.
- F. For raised access flooring systems, verify the following:
1. Access floor complies with installation requirements specified in Division 09 Section "Access Flooring."
 2. Access floor substrate is compatible with carpet tile and adhesive if any.
 3. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than [1/8 inch (3 mm)] <Insert dimension>, protrusions more

than **1/32 inch (0.8 mm)**, and substances that may interfere with adhesive bond or show through surface.

- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- 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 (3 mm)** wide or wider and protrusions more than **1/32 inch (0.8 mm)** unless more stringent requirements are required by manufacturer's written instructions.
- C. 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 carpet tile manufacturer.
- D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: **[As recommended in writing by carpet tile manufacturer] [Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive] [Partial glue down; install periodic tiles with releasable, pressure-sensitive adhesive] [Free lay; install carpet tiles without adhesive].**
- C. Maintain dye lot integrity. Do not mix dye lots in same area.
- D. 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.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders.
- H. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, 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 104, Section 16, "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 096850

SECTION 09 91 00 – PAINTING INTERIOR & EXTERIOR

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. Painting and finishing of interior and exterior exposed items and surfaces throughout the project, except as otherwise indicated.
2. Surface preparation, priming and coats of paint specified are in addition to shop-priming and surface treatment specified under other sections of the work.
3. Field painting of exposed bare and covered pipes and ducts, and hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under the mechanical and electrical work, except as otherwise noted.

- B. "Paint", as used herein, is defined as all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

- C. Paint all exposed surfaces except where the natural finish of the material is specifically noted as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas.

D. Paint prefinished metal items such as:

1. All pre-primed metal building components

- E. Color Coding and Identification: Is specified in respective sections of Divisions 21, through Division 28.

- F. Colors: As selected.

1.3 PAINTING NOT INCLUDED:

- A. The following categories of work are not included as part of the field-applied finish work, or are included in other sections of these specifications.

1. Shop Priming: Unless otherwise specified, shop priming of ferrous metal items is included under the various sections for structural steel, miscellaneous metal, hollow metal work, and similar items. Also, for fabricated components such as architectural woodwork, wood casework, and shop-fabricated or factory-built mechanical and electrical equipment or accessories.
2. Pre-Finished Items: Unless otherwise indicated, do not include painting when factory-finishing is specified for such items as (but not limited to) metal toilet enclosures, prefinished partition systems, acoustic materials, architectural woodwork and casework,

light fixtures, switchgear and distribution cabinets. Prefinished items to be painted are hereinbefore indicated.

3. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, foundation spaces, furred areas, utility tunnels, pipe spaces, duct shafts and elevator shafts.
4. Finished Metal Surfaces: Metal surfaces of anodized aluminum, stainless steel, and chromium plate, copper, bronze and similar finished materials will not require finish painting. (Note: Copper tubing and piping is not a finished metal.)
5. Operating Parts and Labels:
 - a. Moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, and motor and fan shafts will not require finish painting.
 - b. Do not paint over code-required labels, such as Underwriters' Laboratories and Factory Mutual, or equipment identification, performance rating, name, or nomenclature plates. Permanently remove all other labels, prior to painting.

1.4 QUALITY ASSURANCE:

- A. Product Data: For information only, submit copies of manufacturer's technical information including paint label analysis and application instructions for each material proposed for use.
 1. Submit a list of manufacturer's products proposed for use.
 2. Upon approval of the list, submit a detailed schedule of each surface to be painted, and include the specific sealer, primer, underbody and finish coats proposed for each such surface.
 3. After approval is granted, submit complete color catalog(s) for color selections.
- B. Samples: Submit samples for review of color and texture only. Compliance with all other requirements is the exclusive responsibility of the Trade Contractor. Provide a listing of the material and application for each coat of each finish sample.
- C. Maintenance Sample Stock: Provide the Owner with one (1) gallon, air-tight covered, of each applied paint color for future use. Identify each container with manufacturer's name, number and color designation.
- D. Submit certification that materials proposed herein conform to the above requirements and to the fire test requirements of ASTM E84, Class "A" - 0-25 Flame Spread.
 1. Flame Spread Rating: Provide materials with ratings in accordance with NFPA #101, "Life Safety Code", 25 or less in exitways, corridors, stairways, storage rooms or other areas of high hazard; 75 or less elsewhere.
- E. VOC Compliance: Provide LOW VOC materials conforming to the State and local regulations as relating to VOC/VOS requirements at the time of application, and as follows:
 1. VOC Compliance: All paints and coatings must comply with Green Seal Testing Program Limits as follows:
 - a. Non-Flat Primer / Paint: 150g/L. VOC Limit
 - b. Flat Primer / Paint: 50g/L. VOC Limit
- F. Mock-Up:

1. Before proceeding with the Work of this Section, finish one complete space or item of each color scheme required. Show selected colors, finish textures, materials and workmanship.
2. Accepted sample spaces or items will serve as the standard for similar work throughout the project.

1.5 DELIVERY AND STORAGE:

A. Delivery:

1. Deliver all materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and application instructions thereon.
2. Provide labels on each container with the following information:
 - a. Name of title of material.
 - b. Fed. Spec. number, if applicable.
 - c. Manufacturer's stock number.
 - d. Manufacturer's name.
 - e. Contents by volume, for major pigment and vehicle constituents.
 - f. Thinning instructions.
 - g. Application instructions.

B. Storage:

1. Provide a secure space for the storage of all paint materials and equipment for the exclusive use of this work, and maintain and leave it free from fire hazards due to improperly stored rags or thinners.

1.6 JOB CONDITIONS:

- A. Apply water-base paints when the temperature of surfaces to be painted and the surrounding air temperatures are between 50 degrees F. and 90 degrees F., unless otherwise permitted by the paint manufacturer's printed instructions.
- B. Apply solvent-thinned paints when the temperature of surfaces to be painted and the surrounding air temperatures are between 45 degrees F. and 95 degrees F., unless otherwise permitted by the paint manufacturer's printed instructions.
- C. Do not apply paint in snow, rain, fog or mist; or when the relative humidity exceeds 85% or to damp or wet surfaces; unless otherwise permitted by the paint manufacturer's printed instructions.
 1. Continue painting during inclement weather, if the areas and surfaces to be painted are enclosed and heated within the temperature limits specified by the paint manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 COLORS AND FINISHES:

- A. Painting, surface treatments and finishes, are to be determined by the Owner. The color selection for the metal components of the building are to be chosen from the Premiere Color options of the metal building manufacturer and associated components.
- B. Upon completion of the first coat, notify the Architect for his review and approval. This review and approval procedure may be done on a room by room basis so as not to impede the progress of the work.
- C. Color Pigments: Pure, non-fading, applicable types to suit the substrates and service indicated.
 - 1. Lead content in the pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of the paint by weight.
- D. Paint Coordination: Provide finish coats, compatible with prime paints used. Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request, furnish information on characteristics of finish materials proposed for use, to ensure compatible prime coats are used. Provide barrier coats over incompatible primers or remove and reprime, as required. Notify the Architect, in writing, of any anticipated problems using specified coating systems with substrates primed by others.

2.2 MATERIAL QUALITY:

- A. Provide the best quality grade of the various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying the manufacturer's identification as a standard, best-grade product will not be acceptable.
- B. Exterior Paint Manufacturers:
 - 1. Sherwin Williams, as specified.
 - 2. Benjamin Moore, as specified.
 - 3. Or equivalent products by the following: PPG Industries or Devoe
- C. Interior Paint Manufacturers:
 - 1. Sherwin-Williams Co. "Harmony" Coating System as specified.
 - 2. Benjamin Moore Company "Eco-Spec", as specified.
 - 3. Or equivalent products by the following:
 - a. PPG Industries "Pure Performance" Low VOC line
 - b. Devoe "Wonder-Pure" Low VOC line
- D. Proprietary names, used to designate colors or materials, are not intended to imply that products of the named manufacturers are required to the exclusion of equivalent products of other manufacturers.
- E. Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer, and use only within recommended limits.

2.3 EXTERIOR PAINT SYSTEMS:

- A. Provide the following paint systems for the various substrates, as indicated.
- B. Ferrous Metal: (including steel doors and frames, overhead doors, coiling doors, handrails, etc.)

Gloss Finish: (4 mils wet, 1.3 mils dry per coat)

1st Coat - S-W All Surface Enamel Latex Primer, A41W210 (10 mils wet, 5 mils dry)

2nd Coat - S-W A-100 Exterior Latex Gloss, A8 Series

3rd Coat - S-W A-100 Exterior Latex Gloss, A8 Series

(4 mils wet, 1.3 mils dry per coat)

Semi-Gloss Finish : (3-5 mils dry per coat)

1st Coat - S-W All Surface Enamel Latex Primer, A41W210 (10 mils wet, 5 mils dry)

2nd Coat - S-W Metalatex Semi-Gloss Coating, B42 Series

3rd Coat - S-W Metalatex Semi-Gloss Coating, B42 Series

First coat not required on items delivered shop primed.

or;

1st coat - Benjamin Moore M07 Universal Metal Primer- M07

2nd coat - Benjamin Moore D.T.M. Acrylic (Semi-Gloss M29) (Gloss M28)

3rd coat - Benjamin Moore D.T.M. Acrylic (Semi-Gloss M29) (Gloss M28)

- C. Galvanized/Zinc Coated Metal: (architecturally exposed structural steel, including fascia; if not aluminum)

Gloss Finish: (4 mils wet, 1.3 mils dry per coat)

1st Coat - S-W All Surface Enamel Latex Primer, A41W210 (10 mils wet, 5 mils dry)

2nd Coat - S-W A-100 Exterior Latex Gloss, A8 Series

3rd Coat - S-W A-100 Exterior Latex Gloss, A8 Series

Semi-Gloss Finish (3-5 mils dry per coat)

1st Coat - S-W All Surface Enamel Latex Primer, A41W210 (10 mils wet, 5 mils dry)

2nd Coat - S-W Metalatex Semi-Gloss Coating, B42 Series

3rd Coat - S-W Metalatex Semi-Gloss Coating, B42 Series

or;

1st coat - Benjamin Moore M04 Acrylic Metal Primer - M04

2nd coat - Benjamin Moore D.T.M. Acrylic (Semi-Gloss M29) (Gloss M28)

3rd coat- Benjamin Moore D.T.M. Acrylic (Semi-Gloss M29) (Gloss M28)

- D. Aluminum: (including roof top mechanical units; fascia, if not zinc coated)

Semi-Gloss Finish (3-5 mils dry per coat)

1st Coat: S-W Metalatex Semi-Gloss Coating, B42 Series

2nd Coat: S-W Metalatex Semi-Gloss Coating, B42 Series

3rd Coat: S-W Metalatex Semi-Gloss Coating, B42 Series

Gloss (4 mils wet, 1.3 mils dry per coat)

1st Coat: S-W A-100 Exterior Latex Gloss, A8 Series

2nd Coat: S-W A-100 Exterior Latex Gloss, A8 Series

3rd Coat: S-W A-100 Exterior Latex Gloss, A8 Series

(4 mils wet, 1.3 mils dry per coat)

or;

1st coat - Benjamin Moore M04 Acrylic Metal Primer - M04

2nd coat - Benjamin Moore D.T.M. Acrylic (Semi-Gloss M29) (Gloss M28)

3rd coat - Benjamin Moore D.T.M. Acrylic (Semi-Gloss M29) (Gloss M28)

2.4 LOW ODOR - LOW VOC COMPLIANT INTERIOR PAINTS

A. Coordinate with Finish Schedule for material and colors required.

B. Concrete Masonry Units:

1st coat - Sherwin-Williams Loxon Block Surfacer

2nd coat - Sherwin-Williams Harmony Interior Latex Eg-Shel B9 Series

3rd coat - Sherwin-Williams Harmony Interior Latex Eg-Shel B9 Series

or;

1st coat- Benjamin Moore Super Craft Latex Block Filler-285

2nd coat - Benjamin Moore Eco Spec Interior Latex Eggshell 223

3rd coat- Benjamin Moore Eco Spec Interior Latex Eggshell 223

C. Gypsum Drywall System (except ceilings):

1st coat - Sherwin-Williams Harmony Interior Latex Primer B11W900

2nd coat - Sherwin-Williams Harmony Interior Latex Eg-Shel B9 Series

3rd coat - Sherwin-Williams Harmony Interior Latex Eg-Shel B9 Series

or;

1st coat- Benjamin Moore Eco Spec Interior Latex Primer Sealer-231

2nd coat - Benjamin Moore Eco Spec Interior Latex Eggshell 223

3rd coat- Benjamin Moore Eco Spec Interior Latex Eggshell 223

D. Masonry:

1st coat - Sherwin-Williams PrepRite Masonry Primer or Harmony Interior Latex Primer B11W900

2nd coat - Sherwin-Williams Harmony Interior Latex Eg-Shel B9 Series

3rd coat - Sherwin-Williams Harmony Interior Latex Eg-Shel B9 Series

or;

1st coat- Benjamin Moore Acrylic Masonry Sealer-066 or Eco Spec Interior Latex Primer Sealer-231

2nd coat - Benjamin Moore Eco Spec Interior Latex Eggshell 223

3rd coat- Benjamin Moore Eco Spec Interior Latex Eggshell 223

E. Ferrous Metals: (for all exposed to view metal, in finished rooms, including grilles, diffusers, piping, ducts, conduit, metal doors and frames and miscellaneous metals. When concealed from view and in mechanical equipment rooms, spot prime, only):

1st coat - Sherwin-Williams DTM Acrylic Primer/Finish
2nd coat - Sherwin-Williams Harmony Interior Latex Eg-Shel B9 Series
3rd coat - Sherwin-Williams Harmony Interior Latex Eg-Shel B9 Series

or;

1st coat - Benjamin Moore M04 Acrylic Metal Primer-M04
2nd coat - Benjamin Moore Eco Spec Interior Latex Eggshell 223
3rd coat- Benjamin Moore Eco Spec Interior Latex Eggshell 223

F. Ceilings (drywall or concrete):

Flat Finish (4 mils wet, 1.6 mils dry per coat)

1st Coat - S-W Harmony Low Odor Interior Latex Primer, B11W900 (0 VOC)
2nd Coat - S-W Harmony Low Odor Interior Latex Flat, B5 Series (0 VOC)
3rd Coat - S-W Harmony Low Odor Interior Latex Flat, B5 Series (0 VOC)

or;

1st coat Benjamin Moore Super Spec Latex Enamel Undercoater & Primer Sealer- 253
2nd coat Benjamin Moore Moorecraft Super Spec Latex Flat- 275
3rd coat Benjamin Moore Moorecraft Super Spec Latex Flat- 275

G. Aluminum: (for all exposed to view items, including grilles, diffusers, louvers, ducts, conduit and miscellaneous items not prefinished)

Semi-Gloss Finish (4 mils wet, 1.6 mils dry per coat)

1st Coat - S-W ProCryl Universal Primer, B66-310 Series (110 g/L)
2nd Coat - S-W Harmony Low Odor Interior Latex Semi-Gloss, B10 Series (0 VOC)
3rd Coat - S-W Harmony Low Odor Interior Latex Semi-Gloss, B10 Series (0 VOC)

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine the areas and conditions under which painting work is to be applied and do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Starting of painting work will be construed as acceptance of the surfaces and conditions within any particular area.
- C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to the formation of a durable paint film.

3.2 PREPARATION:

A. New Substrates:

- 1. General: Perform preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as specified, for each particular substrate condition.

- a. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for the complete painting of the items and adjacent surfaces. Following completion of painting of each space or area, reinstall the removed items by workmen skilled in the trades involved.
 - b. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program the cleaning and painting so that contaminants from the cleaning process will not fall onto wet, newly-painted surfaces.
 - c. Equipment, factory primed, including but not limited to fire extinguisher cabinets; electric panels, in finished areas; grilles; diffusers; and similar equipment not indicated to be painted "electro-statically" shall be dulled by sanding with #00 sandpaper or other approved material prior to receiving finish coats. Remove all sanding residue with water-moistened rags or other approved method.
2. Cementitious Materials: Prepare cementitious surfaces of concrete, concrete block, and cement plaster to be painted by removing all efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze.
- a. Determine the alkalinity and moisture content of the surfaces by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish paint, correct this condition before application of paint. Do not paint over surfaces where the moisture content exceeds that permitted in the manufacturer's printed directions.
 - b. Coordinate with Division 4. If liquid cleaning solutions are used, determine the condition of the surfaces for paint application.
 - c. Shot blast concrete floors scheduled to be painted to provide a surface texture to receive paint.
 - d. If approved, prepare concrete floor surfaces with a commercial solution of muriatic acid, or other etching cleaner, flush floor with clean water to neutralize acid, and allow to dry before painting. Test slabs for dryness prior to commencing painting.
3. Wood: Clean wood surfaces to be painted of all dirt, oil or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer, before application of the priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.
- a. Wood Items Not Prefinished: Coordinate with respective sections of Divisions 6 and 8. If items are not prefinished, adhere to the following requirements:
 - 1) Prime, stain, or seal wood required to be job-painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling, etc.
 - 2) When transparent finish is required, use spar varnish for backpriming.
 - 3) Backprime paneling on interior partitions only where masonry, plaster or other wet wall construction occurs on backside.
 - 4) Seal tops, bottoms, and cut-outs of unprimed wood doors with a heavy coat of varnish or equivalent sealer immediately upon delivery to job.
4. Ferrous Metals: Clean ferrous surfaces, which are not galvanized or shop-coated, of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning.

- a. Coordinate with Division 4. Determine if liquid cleaning solutions have been removed from surfaces abutting masonry.
 - b. Wire brush or mechanically sand rust spots to bright metal and spot prime.
 - c. Touch-up shop-applied prime coats wherever damaged or bare, where required by other sections of these specifications. Clean and touch-up with the same type shop primer.
5. Galvanized Surfaces: Clean free of oil and surface contaminate with an acceptable non-petroleum based solvent.

3.3 MATERIALS PREPARATION:

- A. Mix and prepare painting materials in accordance with manufacturer's directions.
- B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing and application of paint in a clean condition, free of foreign materials and residue.
- C. Stir materials before application to produce a mixture of uniform density, and stir as required during the application of the materials. Do not stir surface film into the material. Remove the film and if necessary, strain the material before using.

3.4 APPLICATION:

- A. General:
 1. Apply paint in accordance with the manufacturer's directions. Use applicators and techniques best suited for the substrate and type of material being applied.
- B. Apply primer, intermediate and finish coats to not less than the manufacturer's recommended wet film and dry film thicknesses and spreading rates for each of the various types of materials specified.
 1. Verify mil thickness, wet or dry, by use of recommended gauges.
- C. Apply additional coats when undercoats, stains or other conditions show through the final coat of paint, until the paint film is of uniform finish, color and appearance. Give special attention to insure that all surfaces, including edges, corners, crevices, welds and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
- D. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only before final installation of equipment.
- E. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
- F. Paint the back sides of access panels, and removable or hinged covers to match the exposed surfaces.
- G. Finish doors on tops, bottoms and side edges the same as the faces, unless otherwise indicated.
- H. Sand lightly between each succeeding enamel or varnish coat.

- I. Omit the first coat (primer) on metal surfaces which have been shop-primed and touch-up painted, unless otherwise indicated.
- J. Scheduling Painting:
 - 1. Apply the first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 2. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.
- K. Minimum Coating Thickness: Apply each material at not less than the manufacturer's recommended spreading rate, to establish a total dry film thickness as indicated or, if not indicated, as recommended by coating manufacturer.
- L. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to those items exposed to view on the building exterior, in mechanical equipment rooms and in finished spaces.
 - 1. Mechanical items to be painted include, but are not limited to, the following:
 - a. Roof appurtenances including fan housings, exhaust hoods, fan covers, vent stacks, vent covers and grilles.
 - b. Convectors, radiation units, cabinet heaters, unit ventilators.
 - c. Piping, pipe hangers and supports.
 - d. Heat exchangers.
 - e. Tanks.
 - f. Ductwork, insulation.
 - g. Motors and mechanical equipment and supports.
 - h. Accessory items, including grilles, diffusers and louvers.
 - 2. Electrical items to be painted include, but are not limited to, the following:
 - a. Conduit and fittings.
 - b. Panels.
 - c. Panel backboards.
- M. Prime Coats: Apply a prime coat of material which is required to be painted or finished, and which has not been prime coated by others.
 - 1. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.
 - 2. Apply prime coat to all surfaces including surfaces indicated to receive other finishes.
- N. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable.
- O. Transparent (Clear) Finishes: Use multiple coats to produce glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes or other surface imperfections.
 - 1. Provide satin finish for final coats, unless otherwise indicated.

- P. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3.5 CLEAN-UP AND PROTECTION:

- A. Clean-up: During the progress of the work, remove from the site all discarded paint materials, rubbish, cans and rags at the end of each work day.
 - 1. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.
- B. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to the Architect.
 - 1. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.
 - 2. At the completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.

END OF SECTION 09 91 00

SECTION 101100 - VISUAL DISPLAY SURFACES

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. Chalkboards.
2. Markerboards.
3. Tackboards.
4. Visual display rails.
5. Visual display wall panels.
6. Support systems for visual display boards.
7. Sliding visual display units.
8. Visual display conference units.
9. Visual display wall coverings.
10. Electronic markerboards.

B. Related Sections:

1. Division 09 Section "Fabric-Wrapped Panels" for tackable, fabric-covered wall surfaces.
2. Division 10 Section "Display Cases" for **[individually framed and enclosed, wall-mounted bulletin boards] [and for] [bulletin boards in built-in trophy and display cases]**.
3. Division 10 Section "Directories" for bulletin boards within built-in directories.
4. Division 26 Sections for wiring and other electrical work associated with power-operated, visual display surfaces.

1.3 DEFINITIONS

- A. Tackboard: Framed or unframed, tackable, visual display board assembly.
- B. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes chalkboards, markerboards, and tackboards.
- C. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of chalkboards, markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

1.4 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 visual display surfaces.**]
1. Include [**rated capacities, operating characteristics, electrical characteristics and**] individual panel weights for sliding visual display units.
 2. Include computer system requirements for electronic markerboards.
- B. LEED Submittals:
1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
 2. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that the product contains no urea formaldehyde.
 3. Laboratory Test Reports for Credit IEQ 4: For [**adhesives**] [**and**] [**composite wood products**], documentation indicating that products 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. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
1. Show locations of panel joints.
 2. Show locations of special-purpose graphics for visual display surfaces.
 3. Include sections of typical trim members.
 4. Wiring Diagrams: For power, signal, and control wiring.
- D. Samples for Initial Selection: For each type of visual display surface indicated, for units with factory-applied color finishes, and as follows:
1. Actual sections of [**porcelain-enamel face sheet**] [**painting-finish chalkboard**] [**melamine visual display surface**] [**high-pressure-laminate visual display surface**] [**tackboard assembly**] [**visual display wall panel**] [**display rail**] [**visual display wall covering**].
 2. Fabric swatches of [**vinyl-**] [**and**] [**polyester-**] fabric-faced tack assemblies.
 3. Include accessory Samples to verify color selected.
- E. Samples for Verification: For each type of visual display surface indicated.
1. Visual Display Surface: Not less than **8-1/2 by 11 inches (215 by 280 mm)**, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
 2. Trim: **6-inch- (152-mm-)** long sections of each trim profile.
 3. Display Rail: **6-inch- (152-mm-)** long sections.
 4. [**Rail**] [**Modular**] Support System: **6-inch- (152-mm-)** long sections.
 5. Accessories: Full-size Sample of each type of accessory.
- F. Product Schedule: For visual display surfaces. [**Use same designations indicated on Drawings.**]

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
- C. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. **[Operation and]**Maintenance Data: For visual display surfaces **[and power-operated units]** to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of motor-operated, sliding visual display units required for this Project.
- B. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.
- C. 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] <Insert value>** or less.
 - 2. Smoke-Developed Index: **[50] [450] <Insert value>** 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. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate appearance and aesthetic effects and set quality standards for installation.
 - 1. Build mockup of typical **[wall area] <Insert description>** as shown on Drawings. Include accessories.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-built visual display surfaces **[, including factory-applied trim where indicated,]** completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
- B. Store visual display surfaces vertically with packing materials between each unit.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display surfaces 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 surfaces by field measurements before fabrication.
 - 1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.10 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 - 2. Warranty Period: **[50]** <Insert number> years from date of Substantial Completion.
 - 3. Warranty Period: Life of the building.
- B. Special Warranty for Electronic Markerboards: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic markerboards that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: **[Two]** <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Porcelain-Enamel Face Sheet: ASTM A 424, enameling-grade steel, uncoated thickness indicated; with exposed face and edges coated with primer, **1.7-to-2.5-mil-** (0.043-to-0.064-mm-) thick ground coat, and color cover coat; and with concealed face coated with primer and **1.7-to-2.5-mil-** (0.043-to-0.064-mm-) thick ground coat.
 - 1. Matte-Finish Cover Coat: Low reflective; chalk wipes clean with dry cloth or standard eraser. Minimum **2.0-to-2.5-mil-** (0.051-to-0.064-mm-) thick cover coat. Cover and ground coats shall be fused to steel at manufacturer's standard firing temperatures but not less than **1250 deg F** (677 deg C).
 - a. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:<Insert manufacturer's name; product name or designation>**.

- 1) PolyVision Corporation, a Steelcase company; P³ ceramicsteel Chalkboard.
 - 2) **<Insert manufacturer's name; product name or designation>**.
2. Gloss-Finish Cover Coat: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser. Minimum **3.0-to-4.0-mil- (0.076-to-0.102-mm-)** thick cover coat. Cover and ground coats shall be fused to steel at manufacturer's standard firing temperatures but not less than **1475 deg F (802 deg C)**.
 - a. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:<Insert manufacturer's name; product name or designation>**.
 - 1) PolyVision Corporation, a Steelcase company; P³ ceramicsteel Markerboard.
 - 2) **<Insert manufacturer's name; product name or designation>**.
- B. Porcelain-Enamel Face Sheet: Porcelain-enamel-clad, ASTM A 463/A 463M, Type 1, stretcher-leveled aluminized steel, with **0.024-inch (0.60-mm)** uncoated thickness; with porcelain-enamel coating fused to steel at approximately **1000 deg F (538 deg C)**.
1. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
 - a. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:<Insert manufacturer's name; product name or designation>**.
 - 1) Claridge Products and Equipment, Inc.; Vitracite Chalkboard.
 - 2) **<Insert manufacturer's name; product name or designation>**.
 2. Gloss Finish: Low gloss; dry-erase markers wipe clean with dry cloth or standard eraser. Suitable for use as projection screen.
 - a. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:<Insert manufacturer's name; product name or designation>**.
 - 1) Claridge Products and Equipment, Inc.; LCS Markerboard.
 - 2) **<Insert manufacturer's name; product name or designation>**.
- C. Porcelain-Enamel Face Sheet: Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
1. Manufacturers: Subject to compliance with requirements, **[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. Claridge Products and Equipment, Inc.
 - b. PolyVision Corporation; a Steelcase company.
 - c. **<Insert manufacturer's name>**.
 2. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.

3. Gloss Finish: Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.
- D. Melamine: Thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
- E. High-Pressure Plastic Laminate: NEMA LD 3.
- F. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish[**with surface-burning characteristics indicated**].
- G. 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**].
- H. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, [**burlap weave**] <insert texture or pattern>; weighing not less than **13 oz./sq. yd. (440 g/sq. m)**; with surface-burning characteristics indicated.
- I. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than **15 oz./sq. yd. (508 g/sq. m)**; with surface-burning characteristics indicated.
- J. Hardboard: ANSI A135.4, tempered.
- K. Particleboard: ANSI A208.1, Grade M-1[.], [**made with binder containing no urea formaldehyde.**], [**that complies 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."**]
- L. Fiberboard: ASTM C 208.
- M. Extruded Aluminum: **ASTM B 221 (ASTM B 221M)**, Alloy 6063.
- N. Adhesives: Manufacturer's standard product that complies 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 CHALKBOARD ASSEMBLIES

- A. Porcelain-Enamel Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, core material, and [**0.021-inch- (0.53-mm-) thick,**] [**0.013-inch- (0.33-mm-) thick,**] porcelain-enamel face sheet with matte finish.
 1. Manufacturers: Subject to compliance with requirements, [**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. A-1 Visual Systems.
 - b. AARCO Products, Inc.
 - c. ADP Lemco, Inc.
 - d. Aywon.

- e. Bangor Cork Company, Inc.
 - f. Best-Rite Manufacturing.
 - g. Claridge Products and Equipment, Inc.
 - h. Ghent Manufacturing, Inc.
 - i. Marsh Industries, Inc.; Visual Products Group.
 - j. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 - k. PolyVision Corporation; a Steelcase company.
 - l. Tri-Best Visual Display Products.
 - m. <Insert manufacturer's name>.
2. Hardboard Core: **1/4 inch (6 mm)** thick; with [**0.005-inch- (0.127-mm-)** thick, **aluminum foil**] [**0.015-inch- (0.38-mm-)** thick, **aluminum sheet**] [**0.0129-inch- (0.35-mm-)** thick, **galvanized-steel sheet**] backing.
 3. Particleboard Core: **3/8 inch (9.5 mm)** thick; with [**0.005-inch- (0.127-mm-)** thick, **aluminum foil**] [**0.015-inch- (0.38-mm-)** thick, **aluminum sheet**] [**0.0129-inch- (0.35-mm-)** thick, **galvanized-steel sheet**] backing.
 4. Fiberboard Core: [**3/8 inch (9.5 mm)**] [**1/2 inch (13 mm)**] thick; with [**0.001-inch- (0.025-mm-)** thick, **aluminum foil**] [**0.015-inch- (0.38-mm-)** thick, **aluminum sheet**] [**0.0129-inch- (0.35-mm-)** thick, **galvanized-steel sheet**] backing.
 5. Manufacturer's Standard Core: Minimum **1/4 inch (6 mm)** thick, with manufacturer's standard moisture-barrier backing.
 6. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
- B. High-Pressure-Laminate Chalkboards: Balanced, high-pressure, factory-laminated chalkboard assembly of two-ply construction consisting of fiberboard core material and high-pressure-laminate writing surface.
1. Manufacturers: Subject to compliance with requirements, [**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. Best-Rite Manufacturing.
 - b. Ghent Manufacturing, Inc.
 - c. <Insert manufacturer's name>.
- C. Melamine Chalkboards: Fabricated from **1/4-inch- (6-mm-)** thick, sealed and primed hardboard panels permanently bonded with melamine writing surface.
1. Manufacturers: Subject to compliance with requirements, [**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. Best-Rite Manufacturing.
 - b. Marsh Industries, Inc.; Visual Products Group.
 - c. <Insert manufacturer's name>.
- D. Painted-Finish Chalkboards: Fabricated from [**two plies of**] **1/4-inch- (6-mm-)** thick, treated, tempered hardboard panels permanently surfaced with manufacturer's standard, heat-cured organic coating formulated for chalk-receptive matte finish.
1. Manufacturers: Subject to compliance with requirements, [**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. AARCO Products, Inc.

- b. Marsh Industries, Inc.; Visual Products Group.
 - c. <Insert manufacturer's name>.
- E. Natural-Slate Chalkboards: Select grade, resurfaced, natural slate; free from ribbons and other natural marks that impair their functional use and durability as a writing surface.
- 1. Writing surface shall be free of tooling marks, pits, chipping, scratches, and surface spalls in excess of those that can be easily corrected; and shall be free of surface-applied stain, dye, or other artificial coloring.
 - 2. Thickness: Not less than **1/4 inch (6 mm)** or more than **3/8 inch (9.5 mm)** thick with maximum deviation of **1/16 inch (1.6 mm)** when an average thickness of at least **1/4 inch (6 mm)** is maintained.
 - 3. Manufacturers: Subject to compliance with requirements, **[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. <Insert manufacturer's name>.

2.3 MARKERBOARD ASSEMBLIES

- A. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and **[0.021-inch- (0.53-mm-) thick,] [0.013-inch- (0.33-mm-) thick,]** porcelain-enamel face sheet with **[high] [low]-gloss** finish.
- 1. Manufacturers: Subject to compliance with requirements, **[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. AARCO Products, Inc.
 - b. ADP Lemco, Inc.
 - c. Aywon.
 - d. Bangor Cork Company, Inc.
 - e. Best-Rite Manufacturing.
 - f. Claridge Products and Equipment, Inc.
 - g. Egan Visual Inc.
 - h. Ghent Manufacturing, Inc.
 - i. Marsh Industries, Inc.; Visual Products Group.
 - j. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 - k. PolyVision Corporation; a Steelcase company.
 - l. Tri-Best Visual Display Products.
 - m. <Insert manufacturer's name>.
 - 2. Hardboard Core: **1/4 inch (6 mm)** thick; with **[0.005-inch- (0.127-mm-) thick, aluminum foil] [0.015-inch- (0.38-mm-) thick, aluminum sheet] [0.013-inch- (0.35-mm-) thick, galvanized-steel sheet]** backing.
 - 3. Particleboard Core: **[3/8 inch (9.5 mm)] [1/2 inch (13 mm)]** thick; with **[0.005-inch- (0.127-mm-) thick, aluminum foil] [0.015-inch- (0.38-mm-) thick, aluminum sheet] [0.013-inch- (0.35-mm-) thick, galvanized-steel sheet]** backing.
 - 4. Fiberboard Core: **[3/8 inch (9.5 mm)] [1/2 inch (13 mm)]** thick; with **[0.001-inch- (0.025-mm-) thick, aluminum foil] [0.015-inch- (0.38-mm-) thick, aluminum sheet] [0.013-inch- (0.35-mm-) thick, galvanized-steel sheet]** backing.
 - 5. Manufacturer's Standard Core: Minimum **1/4 inch (6 mm)** thick, with manufacturer's standard moisture-barrier backing.

6. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
- B. Melamine Markerboards: Fabricated from **1/4-inch- (6-mm-)** thick, sealed and primed hardboard panels permanently bonded with melamine or another high-pressure-laminate writing surface.
1. Manufacturers: Subject to compliance with requirements, **[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. AARCO Products, Inc.
 - b. Ghent Manufacturing, Inc.
 - c. Marsh Industries, Inc.; Visual Products Group.
 - d. **<Insert manufacturer's name>**.
- C. High-Pressure-Laminate Markerboard Assembly: Balanced, high-pressure, factory-laminated chalkboard assembly of three-ply construction consisting of backing sheet, fiberboard core material, and high-pressure-laminate writing surface.
1. Manufacturers: Subject to compliance with requirements, **[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. Best-Rite Manufacturing.
 - b. EverProducts by Glenroy Inc.
 - c. Marsh Industries, Inc.; Visual Products Group.
 - d. **<Insert manufacturer's name>**.

2.4 TACKBOARD ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, **[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. A-1 Visual Systems.
 2. AARCO Products, Inc.
 3. ADP Lemco, Inc.
 4. Aywon.
 5. Bangor Cork Company, Inc.
 6. Best-Rite Manufacturing.
 7. Claridge Products and Equipment, Inc.
 8. Egan Visual Inc.
 9. EverProducts by Glenroy Inc.
 10. Ghent Manufacturing, Inc.
 11. Marsh Industries, Inc.; Visual Products Group.
 12. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 13. PolyVision Corporation; a Steelcase company.
 14. Tri-Best Visual Display Products.
 15. **<Insert manufacturer's name>**.
- B. Natural-Cork Tackboard **<Insert designation>**: **1/16-inch- (1.6-mm-)** thick, natural cork sheet factory laminated to **[3/8-inch- (9.5-mm-)] [7/16-inch- (11-mm-)]** thick fiberboard backing.

- C. Natural-Cork Tackboard <Insert designation>: 1/8-inch- (3-mm-) thick, natural cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
- D. Natural-Cork Tackboard <Insert designation>: 1/4-inch- (6-mm-) thick, natural cork sheet factory laminated to 1/4-inch- (6-mm-) thick [hardboard] [particleboard] backing.
- E. Plastic-Impregnated-Cork Tackboard <Insert designation>: 1/8-inch- (3-mm-) thick, plastic-impregnated cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
- F. Plastic-Impregnated-Cork Tackboard <Insert designation>: 1/4-inch- (6-mm-) thick, plastic-impregnated cork sheet factory laminated to 1/4-inch- (6-mm-) thick [hardboard] [particleboard] backing.
- G. Vinyl-Fabric-Faced Tackboard <Insert designation>: Vinyl fabric factory laminated to [3/8-inch- (9.5-mm-)] [7/16-inch- (11-mm-)] [1/2-inch- (13-mm-)] thick fiberboard backing.
- H. Vinyl-Fabric-Faced Tackboard <Insert designation>: 1/16-inch- (1.6-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
- I. Vinyl-Fabric-Faced Tackboard <Insert designation>: 1/8-inch- (3-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
- J. Vinyl-Fabric-Faced Tackboard <Insert designation>: 1/4-inch- (6-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 1/4-inch- (6-mm-) thick [hardboard] [particleboard] backing.
- K. Polyester-Fabric-Faced Tackboard <Insert designation>: Polyester fabric factory laminated to [3/8-inch- (9.5-mm-)] [1/2-inch- (13-mm-)] thick fiberboard backing.
- L. Polyester-Fabric-Faced Tackboard <Insert designation>: 1/16-inch- (1.6-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
- M. Polyester-Fabric-Faced Tackboard <Insert designation>: 1/8-inch- (3-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
- N. Polyester-Fabric-Faced Tackboard <Insert designation>: 1/4-inch- (6-mm-) thick, polyester-fabric-faced cork sheet factory laminated to 1/4-inch- (6-mm-) thick [hardboard] [particleboard] backing.
- O. <Insert tackboard>.

2.5 VISUAL DISPLAY RAILS

- A. Manufacturers: Subject to compliance with requirements, [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. AARCO Products, Inc.
 2. Bangor Cork Company, Inc.
 3. Best-Rite Manufacturing.
 4. Claridge Products and Equipment, Inc.
 5. Ghent Manufacturing, Inc.
 6. Marsh Industries, Inc.; Visual Products Group.
 7. Platinum Visual Systems; a division of ABC School Equipment, Inc.

8. PolyVision Corporation; a Steelcase company.
9. Tri-Best Visual Display Products.
10. <Insert manufacturer's name>.

- B. General: Manufacturer's standard, aluminum-framed, tackable [cork] [fabric] visual display surface fabricated into narrow rail shape and designed for displaying material.

2.6 VISUAL DISPLAY WALL PANELS

- A. Manufacturers: Subject to compliance with requirements, [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. A-1 Visual Systems.
2. ADP Lemco, Inc.
3. Best-Rite Manufacturing.
4. Claridge Products and Equipment, Inc.
5. Egan Visual Inc.
6. Marsh Industries, Inc.; Visual Products Group.
7. Platinum Visual Systems; a division of ABC School Equipment, Inc.
8. PolyVision Corporation; a Steelcase company.
9. Tri-Best Visual Display Products.
10. <Insert manufacturer's name>.

- B. Marker Wall Sheets: Fabricated from[**0.021-inch (0.53-mm) uncoated thickness,**] porcelain-enamel face sheets; for direct application to wall surface.

- C. Marker Wall Panels: Fabricated from markerboard assembly indicated.

- D. Tack Wall Panels: With tackable surface.

1. Fabricated from tackboard assembly indicated.
2. Natural Cork: [**1/8-inch- (3-mm-)**] [**1/4-inch- (6-mm-)**] thick, natural cork sheet for direct application to wall surface.
3. Plastic-Impregnated Cork: [**1/8-inch- (3-mm-)**] [**1/4-inch- (6-mm-)**] thick, plastic-impregnated cork sheet for direct application to wall surface.
4. Vinyl Fabric-Faced Cork: **1/4-inch- (6-mm-)** thick, vinyl-fabric-faced cork sheet for direct application to wall surface.
5. Polyester-Fabric-Faced Cork: **1/4-inch- (6-mm-)** thick, polyester-fabric-faced cork sheet for direct application to wall surface.

- E. Joint Accessories: Manufacturer's standard, [**exposed trim**] [**concealed aluminum or steel spline**] at butt joints.

- F. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific tack wall panels and substrate application, as recommended in writing by visual display surface manufacturer.

1. Adhesive shall have a VOC content of [**50**] <Insert value> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive 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."

- G. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "[**Interior Painting**] <Insert Section title>" and recommended in writing by visual display surface manufacturer for intended substrate.

2.7 RAIL SUPPORT SYSTEM FOR VISUAL DISPLAY BOARDS

- A. Manufacturers: Subject to compliance with requirements, [**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. Best-Rite Manufacturing.
 2. Egan Visual Inc.
 3. KOH Design, Inc.
 4. Peter Pepper Products, Inc.
 5. PolyVision Corporation; a Steelcase company.
 6. <Insert manufacturer's name>.
- B. Support Rails: Horizontal, wall-mounted, extruded-aluminum rails designed to receive hanger clip and to support visual display boards[; **capable of gripping and suspending paper directly from rail**].
1. Finish: [**Clear anodic**] [**Color anodic**] [**Baked enamel**] [**Powder coat**].
 2. Color and Gloss: [**Light bronze**] [**Medium bronze**] [**Dark bronze**] [**Black**] [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color and gloss>.
- C. Hanger Clips: Extruded aluminum with finish to match rails; designed to support independent visual display boards by engaging support rail and top trim of board.
- D. Visual Display Panels: Fabricated from not less than **3/8-inch- (9.5-mm-)** thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage, and with aluminum trim designed to engage hanger clips.

2.8 MODULAR SUPPORT SYSTEM FOR VISUAL DISPLAY BOARDS

- A. Manufacturers: Subject to compliance with requirements, [**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. AARCO Products, Inc.
 2. Best-Rite Manufacturing.
 3. Claridge Products and Equipment, Inc.
 4. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 5. PolyVision Corporation; a Steelcase company.
 6. <Insert manufacturer's name>.
- B. Standards: **72-inch- (1829-mm-)** long, extruded-aluminum slotted standards designed for supporting visual display boards on panel clips. Standards shall be punched at not less than [**4 inches (100 mm)**] <Insert dimension> o.c.
1. Finish: [**Clear anodic**] [**Color anodic**] [**Baked enamel**] [**Powder coat**].

2. Color and Gloss: [**Light bronze**] [**Medium bronze**] [**Dark bronze**] [**Black**] [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color and gloss>.

C. Panel Clips: Extruded aluminum or steel with finish to match standards.

2.9 SLIDING VISUAL DISPLAY UNITS

A. Horizontal-Sliding Visual Display Units: Factory-fabricated units consisting of extruded-aluminum tubular frame, fixed-rear visual display panel, aluminum-framed horizontal-sliding panels, and extruded-aluminum fascia that conceals overhead sliding track; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.

1. Manufacturers: Subject to compliance with requirements, [**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. A-1 Visual Systems.
 - b. AARCO Products, Inc.
 - c. ADP Lemco, Inc.
 - d. Aywon.
 - e. Best-Rite Manufacturing.
 - f. Claridge Products and Equipment, Inc.
 - g. Ghent Manufacturing, Inc.
 - h. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 - i. PolyVision Corporation; a Steelcase company.
 - j. Tri-Best Visual Display Products.
 - k. <Insert manufacturer's name>.
2. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall length of unit.
3. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than [**one-third**] [**one-half**] of overall length of unit.
4. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface, and fixed front panel on each side of unit equal to not less than one-quarter of overall length of unit. Provide four sliding panels, each equal to not less than one-quarter of overall length of unit.
 - a. Swinging Doors: Fabricated from same construction as sliding panels and supported on full-height continuous hinges. Provide visual display surface on both sides of each door.
5. Sliding Panels: Fabricated from not less than [**3/8-inch- (9.5-mm-)**] <Insert dimension> thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage.
 - a. Fabricate sliding panels with **0.021-inch (0.53-mm)** uncoated thickness, porcelain-enamel face sheets.
6. Hardware: Manufacturer's standard, extruded-aluminum overhead track and channel-shaped bottom guides; with two nylon ball-bearing carriers and two nylon rollers for each sliding panel.

- B. 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; designed for recessed mounting. Provide panels that operate smoothly without vibration or chatter.
1. Manufacturers: Subject to compliance with requirements, **[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. AARCO Products, Inc.
 - b. ADP Lemco, Inc.
 - c. Aywon.
 - d. Claridge Products and Equipment, Inc.
 - e. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 - f. PolyVision Corporation; a Steelcase company.
 - g. Tri-Best Visual Display Products.
 - h. **<Insert manufacturer's name>**.
 2. Type: Tubular frame on **[four sides] [top and two sides, with sides extending to floor; with kick panel to conceal sliding panels]**. Unit shall be designed to support panels independent of wall.
 3. Two-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide two sliding panels, each equal to not less than one-half of overall height of unit.
 4. Three-Track Units: Fabricate unit with fixed rear panel covering entire rear surface. Provide three sliding panels, each equal to not less than one-half of overall height of unit.
 5. Four-Track Units: Fabricate unit with fixed rear panel centered in and covering not less than one-half of rear surface. Provide four sliding panels, each equal to not less than one-half of overall height of unit.
 6. Sliding Panels: Fabricated from not less than **[3/8-inch- (9.5-mm-)] <Insert dimension>** thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage.
 - a. Fabricate sliding panels with **0.021-inch (0.53-mm)** uncoated thickness, porcelain-enamel face sheets.
 7. Hardware: Manufacturer's standard, neoprene ball-bearing end rollers, four on each side of each sliding panel. Counterbalance each sliding panel with lead 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.
 8. Motorized Operation: Provide not less than one motor with gearhead reducers for each sliding panel, mounted above visual display unit and connected to sliding panels with steel aircraft cable. Provide removable cover plate for access to motor. Equip motors with limit switches to automatically stop motor at each end of travel.
 - a. Electric Motors: UL approved or recognized, totally enclosed, complying with NEMA MG 1, with thermal-overload protection; 1/15 hp, single phase, **[110] [220] V**, 60 Hz.
 - b. Control Station: Three-position, **[maintained] [momentary]**-contact, switch-operated control station with open, close, and off functions; with NEMA ICS 6, Type 1 enclosure. Provide **[one] <Insert number>** control station(s) for each sliding panel unit.
 - c. Key Switch: Provide supplementary key switch for each control station. Furnish two keys for each control station, keyed alike.

2.10 VISUAL DISPLAY CONFERENCE UNITS

- A. Manufacturers: Subject to compliance with requirements, **[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. A-1 Visual Systems.
 2. AARCO Products, Inc.
 3. ADP Lemco, Inc.
 4. Best-Rite Manufacturing.
 5. Claridge Products and Equipment, Inc.
 6. Egan Visual Inc.
 7. Ghent Manufacturing, Inc.
 8. Marsh Industries, Inc.; Visual Products Group.
 9. Peter Pepper Products, Inc.
 10. Platinum Visual Systems; a division of ABC School Equipment, Inc.
 11. PolyVision Corporation; a Steelcase company.
 12. **<Insert manufacturer's name>**.
- B. Visual Display Conference Units: Factory-fabricated units consisting of hinged-door wood cabinet with perimeter face frame, sides, and back; not less than **3-inch (75-mm)** interior depth and designed for surface wall mounting. Fabricate inside of cabinet and cabinet doors with fixed visual display surfaces.
1. Wood Cabinets: Fabricated from solid wood with integral, solid-wood markertray. Fabricate hinged door panels with solid wood frame and wood-veneer exterior surface.
 2. Plastic-Laminate Cabinets: Cabinet and hinged door panels fabricated from manufacturer's standard, high-pressure, plastic-laminate-finished panels; with integral markertray.
 3. Hardware: Manufacturer's standard, full-height continuous hinges[, **wire door pulls,**] and door bumpers.
 4. Projection Screens: Manufacturer's standard, pull-down, matte, white projection screen, not less than **8 inches (200 mm)** smaller in each direction than overall cabinet size, and mounted above rear visual display surface.
 5. Fluorescent Light: Manufacturer's standard, not less than **24 inches (610 mm)** long, and mounted above rear visual display surface.

2.11 VISUAL DISPLAY WALL COVERINGS

- A. Manufacturers: Subject to compliance with requirements, **[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. Best-Rite Manufacturing.
 2. Egan Visual Inc.
 3. Marsh Industries, Inc.; Visual Products Group.
 4. Omnova Solutions Inc.; Decorative Products; Commercial Wallcovering.
 5. walltalkers; a division of RJF International Corporation.
 6. **<Insert manufacturer's name>**.
- B. Visual Display Wall Covering: Intended for use with dry-erase markers[**and as a projection surface**] and consisting of [**low**] [**moderate**] [**high**]-gloss, plastic film bonded to fabric backing; not less than [**0.012-mil (0.0003-mm)**] [**0.020-mil (0.0005-mm)**] total thickness.

1. Surface Graphics: **2-inch- (50-mm-)** square grid.
 2. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>**.
- C. Magnetic Visual Display Wall Covering: Intended for use with dry-erase markers and magnetic aids and consisting of moderate-gloss plastic film bonded to ferrous-powdered fabric backing; not less than **0.025-mil (0.0006-mm)** total thickness.
1. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>**.
- D. Adhesive: Mildew-resistant, nonstaining[, **strippable**] adhesive, for use with specific wall covering and substrate application, as recommended in writing by wall covering manufacturer.
1. Adhesive shall have a VOC content of **[50] <Insert value>** g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive 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."
- E. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "**[Interior Painting] <Insert Section title>**" and recommended in writing by wall covering manufacturer for intended substrate.

2.12 ELECTRONIC MARKERBOARDS

- A. General: Provide manufacturer's standard electronic markerboard that consists of touch-sensitive writing surface connected to microcomputer via RS-232 serial cable and that electronically records writing with standard dry-erase markers. Equip unit with cables, software, pens, erasers, mounting hardware, and accessories required for a complete installation.
1. Manufacturers: Subject to compliance with requirements, **[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. Claridge Products and Equipment, Inc.
 - b. Egan Visual Inc.
 - c. Ghent Manufacturing, Inc.
 - d. PolyVision Corporation; a Steelcase company.
 - e. SMART Technologies Inc.
 - f. **<Insert manufacturer's name>**.
- B. Software: Capable of real-time recording, saving, and printing of everything that is written and drawn on electronic markerboard; with **[Windows] [Macintosh]** operating system.
1. File Export Formats: BMP, WMF, HTML, and vector-based formats.
 2. Compatibility: Compatible with Microsoft NetMeeting or other T.120-compliant software.
 3. Features: Capable of the following:
 - a. Saving directly from screen.
 - b. Erasing portions of screen.
 - c. Printing directly from screen.
 - d. Saving individual screens as separate pages.
 - e. Showing onscreen **[toolbar] [keyboard]**.

- f. Recognizing not less than four pen colors.
 - g. Recognizing finger touch control for presentations.
 - h. Connecting multiple electronic markerboards to a single computer.
 - i. Showing online help and tutorial.
- C. Overall Size: Approximately **[48 inches high by 60 inches wide (1219 mm high by 1524 mm wide)]** <Insert dimensions>.
- D. Mounting: **[Wall mounted] [Supported by rail support system]** <Insert requirements>.

2.13 [CHALKBOARD] [MARKERBOARD] [AND] [TACKBOARD] ACCESSORIES

- A. Aluminum Frames[and Trim]: Fabricated from not less than **0.062-inch- (1.57-mm-)** thick, extruded aluminum; **[standard size and shape] [slim size and standard shape] [of size and shape indicated on Drawings]** <Insert size and shape>.
- 1. Field-Applied Trim: Manufacturer's standard, **[snap-on trim with no visible screws or exposed joints] [slip-on trim] [screw-on trim with Phillips flat-head screws]**.
 - 2. Factory-Applied Trim: Manufacturer's standard.
- B. Factory-Applied Wood Trim: **[Red oak] [Walnut] [Manufacturer's standard species]** <Insert species>, not less than **1/2 inch (13 mm)** thick; **[standard size and shape] [of size and shape indicated on Drawings]** <Insert size and shape>.
- C. Field-Applied Wood Trim: Comply with requirements specified in Division 06 Section "[**Finish Carpentry] [Interior Architectural Woodwork]**."
- D. Chalktray: Manufacturer's standard, continuous.
- 1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
 - 2. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
- E. Map Rail: Provide the following accessories:
- 1. Display Rail: Continuous and integral with map rail; fabricated from cork approximately **1 to 2 inches (25 to 50 mm)** wide.
 - 2. End Stops: Located at each end of map rail.
 - 3. Map Hooks: **[Two] <Insert number>** map hooks for every **[48 inches (1219 mm)] [1200 mm] <Insert dimension>** of map rail or fraction thereof.
 - 4. Map Hooks and Clips: **[Two] <Insert number>** map hooks with flexible metal clips for every **[48 inches (1219 mm)] [1200 mm] <Insert dimension>** of map rail or fraction thereof.
 - 5. Flag Holder: **[One] <Insert number>** for each room.
 - 6. Paper Holder: Extruded aluminum; designed to hold paper by clamping action.
- F. Special-Purpose Graphics: Fuse or paint the following graphics into surface of porcelain-enamel visual display unit:
- 1. Semivisible writing guidelines.
 - 2. Penmanship lines.
 - 3. Music staff lines.
 - 4. Grid, **1 inch (25 mm)** square.
 - 5. Graph coordinates, rectangular.

6. Horizontal lines, 2 inches (50 mm) o.c.
7. Polar coordinates.
8. USA map.
9. World map.
10. Soccer field.
11. Football field.
12. Basketball court.
13. <Insert description of special-purpose graphics>.

2.14 FABRICATION

- A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
- B. Natural-Slate Chalkboards: Surface slate panels to a natural plane. Grind and hone to smooth, uniform finish equivalent to that obtained by minimum 180 grit and maximum 220 grit.
 1. Cut joints straight and true. Space joints symmetrically. Fit and match panels before shipment to provide continuous, uniform writing surface.
 2. Length: Furnish panels approximately equal in length with permissible variation not more than 3 inches (75 mm) in either direction of equal spacing. Allow 1/4-inch (6-mm) clearance at trim in length and width for fitting. Provide lengths of panels in each space as follows:
 - a. Up to 5 feet (1.5 m); one panel.
 - b. More than 5 feet (1.5 m) but less than 9 feet (2.7 m); two panels.
 - c. More than 9 feet (2.7 m) but less than 13.5 feet (4.1 m); three panels.
 - d. More than 13.5 feet (4.1 m) but less than 18 feet (5.5 m); four panels.
 - e. More than 18 feet (5.5 m) but less than 22.5 feet (6.9 m); five panels.
 - f. More than 22.5 feet (6.9 m) but less than 27 feet (8.2 m); six panels.
- C. Visual Display Boards: [Factory] [Field] assemble visual display boards unless otherwise indicated.
 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
- D. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.
 1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, [balanced around center of board, as acceptable to Architect] [as indicated on approved Shop Drawings].
 2. Provide manufacturer's standard vertical-joint [spline] [H-trim] system between abutting sections of [chalkboards] [markerboards].
 3. Provide manufacturer's standard mullion trim at joints between [chalkboards] [markerboards] [and] [tackboards] of combination units.
 4. Where size of visual display boards 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.
- E. Modular Visual Display Boards: Fabricated with integral panel clips attached to core material.

- F. Aluminum Frames[**and Trim**]: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.15 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 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.

2.16 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils (0.04 mm)**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.17 VISUAL DISPLAY SURFACE SCHEDULE

- A. Visual Display Board <Insert drawing designation>: [Factory] [Field] assembled.
 1. Chalkboard: [Porcelain-enamel] [High-pressure laminate] [Melamine] [Painted-finish] [Natural-slate] chalkboard assembly.
 - a. Color: [Green] [Blue] [Brown] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
 2. Markerboard: [Porcelain-enamel] [Melamine] [High-pressure-laminate] markerboard assembly.
 - a. Color: [White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].
 3. Corners: [Square] [Rounded].
 4. Width: [As indicated on Drawings] <Insert dimension>.
 5. Height: [As indicated on Drawings] <Insert dimension>.
 6. Mounting: [Wall] [Rail support system].
 7. Mounting Height: [As indicated on Drawings] <Insert dimension>.

8. **[Factory] [Field]-Applied Aluminum Trim: [Manufacturer's standard] <Insert description> with [clear anodic] [color anodic] [baked-enamel] [powder-coat] finish.**
 - a. Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities].**
 9. **[Factory] [Field]-Applied Wood Trim: <Insert species> with [opaque] [transparent] finish.**
 10. **Factory-Applied Vinyl Trim: [Dark brown] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
 11. Accessories:
 - a. Chalktray: **[Box] [Solid] type.**
 - b. Map rail with **[display rail] [end stops] [map hooks] [map hooks and clips] [and] [flag holder].**
- B. Tackboard **<Insert drawing designation>**: **[Factory] [Field]** assembled.
1. Tack Surface: Natural-cork tackboard assembly **<Insert designation>**.
 2. Tack Surface: Plastic-impregnated-cork tackboard assembly **<Insert designation>**.
 3. Tack Surface: Vinyl-fabric-faced tackboard assembly **<Insert designation>**.
 4. Tack Surface: Polyester-fabric-faced tackboard assembly **<Insert designation>**.
 - a. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
 5. Corners: **[Square] [Rounded].**
 6. Width: **[As indicated on Drawings] <Insert dimension>**.
 7. Height: **[As indicated on Drawings] <Insert dimension>**.
 8. Mounting: **[Wall] [Rail support system].**
 9. Mounting Height: **[As indicated on Drawings] <Insert dimension>**.
 10. Edges: **[Concealed by trim] [Wrapped with fabric].**
 - a. **[Factory] [Field]-Applied Aluminum Trim: [Manufacturer's standard] <Insert description> style, with [clear anodic] [color anodic] [baked-enamel] [powder-coat] finish.**
 - 1) Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors and color densities].**
 - b. **[Factory] [Field]-Applied Wood Trim: <Insert species> with [opaque] [transparent] finish.**
- C. Visual Display Rail **<Insert drawing designation>**: **[Factory] [Field]** assembled.
1. Tack Surface: Natural-cork tackboard assembly **<Insert designation>**.
 2. Tack Surface: Plastic-impregnated-cork tackboard assembly **<Insert designation>**.
 3. Tack Surface: Vinyl-fabric-faced tackboard assembly **<Insert designation>**.
 4. Tack Surface: Polyester-fabric-faced tackboard assembly **<Insert designation>**.

- a. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
 5. Size: **[1 inch (25 mm)] [2 inches (50 mm)] [3 inches (75 mm)]** high by length indicated on Drawings.
 6. Edges: **[Extruded-aluminum trim] [Wrapped with fabric].**
 7. Ends: **[Aluminum] [Not required].**
 8. Aluminum Finish: **[Clear anodic] <Insert description> finish.**
- D. Visual Display Wall Panels **<Insert drawing designation>**: Consisting of the following visual display surface:
1. Marker Wall Sheet: Porcelain-enamel face sheet with high-gloss cover coat.
 - a. Color: **[White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
 2. Marker Wall Panel: **[Porcelain-enamel] [High-pressure-laminate]** markerboard assembly.
 - a. Color: **[White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
 3. Tack Wall Panel: Natural-cork tack**[board]** assembly **<Insert designation>**.
 4. Tack Wall Panel: Plastic-impregnated-cork tack**[board]** assembly **<Insert designation>**.
 5. Tack Wall Panel: Vinyl-fabric-faced tack**[board]** assembly **<Insert designation>**.
 6. Tack Wall Panel: Polyester-fabric-faced tack**[board]** assembly **<Insert designation>**.
 - a. Panel-Joint Edges: **[Wrapped with fabric] [Concealed by fabric-covered trim].**
 - b. Top-of-Wall Edges: **[Wrapped with fabric] [Concealed by fabric-covered trim].**
 - c. Bottom-of-Wall Edges: **[Wrapped with fabric] [Concealed by fabric-covered trim].**
 - d. Corners: **[Wrapped with fabric] [Concealed by fabric-covered trim].**
 - e. Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
 7. Width: **[Full width of wall] [As indicated on Drawings] <Insert dimension>**.
 8. Height: **[Full height of wall] [Full height of wall above base] [As indicated on Drawings] <Insert dimension>**.
- E. Sliding Visual Display Unit **<Insert drawing designation>**:
1. Horizontal-Sliding Type: **[Two-track unit] [Three-track unit] [Four-track unit] [Four-track unit with two swinging doors].**
 2. Vertical-Sliding Type: **[Two] [Three] [Four]-track unit with tubular frame on [four sides] [top and two sides with kick panel].**
 - a. Fixed Rear Panel: **[Porcelain-enamel] [Painted-finish] [High-pressure-laminate]** chalkboard assembly.
 - 1) Color: **[Green] [Blue] [Brown] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**

- b. Fixed Rear Panel: **[Porcelain-enamel] [High-pressure-laminate]** markerboard assembly.
 - 1) Color: **[White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
- c. Fixed Rear Panel: Natural-cork tackboard assembly **<Insert designation>**.
- d. Fixed Rear Panel: Plastic-impregnated-cork tackboard assembly **<Insert designation>**.
- e. Fixed Rear Panel: Vinyl-fabric-faced tackboard assembly **<Insert designation>**.
- f. Fixed Rear Panel: Polyester-fabric-faced tackboard assembly **<Insert designation>**.
 - 1) Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
- g. Sliding Panels: **[Porcelain-enamel] [Painted-finish] [High-pressure-laminate]** chalkboard assembly.
 - 1) Color: **[Green] [Blue] [Brown] [Black] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
- h. Sliding Panels: **[Porcelain-enamel] [High-pressure-laminate]** markerboard assembly.
 - 1) Color: **[White] [Beige] [Tan] [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
- i. Sliding Panels: Natural-cork tackboard assembly **<Insert designation>**.
- j. Sliding Panels: Plastic-impregnated-cork tackboard assembly **<Insert designation>**.
- k. Sliding Panels: Vinyl-fabric-faced tackboard assembly **<Insert designation>**.
- l. Sliding Panels: Polyester-fabric-faced tackboard assembly **<Insert designation>**.
 - 1) Color: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from full range of industry colors].**
- 3. Overall Width: **[As indicated on Drawings] <Insert dimension>**.
- 4. Overall Height: **[As indicated on Drawings] <Insert dimension>**.
- 5. Mounting Height: **[As indicated on Drawings] <Insert dimension>**.
- 6. **[Factory] [Field]-Applied Aluminum Trim: [Manufacturer's standard] <Insert description>**.
 - a. Finish: **[Clear anodic] <Insert description>**.
- 7. Accessories:
 - a. Chalktray.
 - b. Map rail with **[display rail] [end stops] [map hooks] [map hooks and clips] [and] [flag holder].**

- c. Locks.
- d. Easel pad clamps.

F. Visual Display Conference Unit <Insert drawing designation>:

1. Cabinet Material: Solid [red oak] [walnut] [mahogany] <Insert species> with [natural lacquered] [oiled] [stained] finish.
2. Cabinet Material: High-pressure plastic laminate.
 - a. Color: [Match Architect's sample] [As indicated by referencing manufacturer's designations] [As selected by Architect from full range of industry colors].
3. Fixed Rear Panel: [Porcelain-enamel] [High-pressure-laminate] markerboard assembly.
 - a. Color: [White] [Beige] [Tan] [Match Architect's sample] [As indicated by referencing manufacturer's designations] [As selected by Architect from full range of industry colors].
4. Inside Surface of Doors: Natural-cork tackboard assembly <Insert designation>.
5. Inside Surface of Doors: Plastic-impregnated-cork tackboard assembly <Insert designation>.
6. Inside Surface of Doors: Vinyl-fabric-faced tackboard assembly <Insert designation>.
7. Inside Surface of Doors: Polyester-fabric-faced tackboard assembly <Insert designation>.
 - a. Color: [Match Architect's sample] [As indicated by referencing manufacturer's designations] [As selected by Architect from full range of industry colors].
8. Inside Surface of Doors: [Porcelain-enamel] [High-pressure-laminate] markerboard assembly, color to match fixed rear panel.
9. Corners: [Square] [Rounded].
10. Width: [48 inches (1219 mm)] [As indicated on Drawings] <Insert dimension>.
11. Height: [36 inches (914 mm)] [48 inches (1219 mm)] [72 inches (1829 mm)] [As indicated on Drawings] <Insert dimension>.
12. Mounting Height: [As indicated on Drawings] <Insert dimension>.
13. Accessories:
 - a. Flip-chart pad clamp.
 - b. Cylinder lock.
 - c. Pull-down projection screen.
 - d. Fluorescent light.

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 roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.
- C. Examine walls and partitions for proper preparation and backing for visual display surfaces.
- D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- E. 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 that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.
- 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 surfaces and wall surfaces.
 - 1. Prime wall surfaces indicated to receive **[direct-applied, visual display tack wall panels] [visual display wall coverings]** and as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - 2. Prepare surfaces to receive visual display wall coverings and test for moisture according to requirements specified in Division 09 Section "Wall Coverings."
 - 3. Prepare substrates indicated to receive visual display wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
 - a. Moisture Content: Maximum of **[4] <Insert number>** percent when tested with an electronic moisture meter.
 - b. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - c. Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - d. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - e. Painted Surfaces: Treat areas susceptible to pigment bleeding.
- D. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION, GENERAL

- 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.
 - 1. Mounting Height **[for Grades K through 3] <Insert description>**: **[24 inches (610 mm)] <Insert dimension>** above finished floor to top of chalktray.

2. Mounting Height [for Grades 4 through 6] <Insert description>: [28 inches (711 mm)] <Insert dimension> above finished floor to top of chalktray.
3. Mounting Height [for Grades 7 and Higher] <Insert description>: [36 inches (914 mm)] <Insert dimension> above finished floor to top of chalktray.

3.4 INSTALLATION OF FIELD-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES

- A. Field-Assembled Visual Display Units: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
 1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, [balanced around center of board, as acceptable to Architect] [as indicated on approved Shop Drawings].
 2. Provide manufacturer's standard vertical-joint [spline] [H-trim] system between abutting sections of [chalkboards] [markerboards].
 3. Provide manufacturer's standard mullion trim at joints between [chalkboards] [markerboards] [and] [tackboards] of combination units.
 4. Where size of visual display boards 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.
- B. Natural-Slate Chalkboards: Align and level joints between adjoining panels and apply manufacturer's recommended joint-filler compound. Hone and finish joints to continuous even plane.

3.5 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES

- A. Visual Display Boards: Attach visual display boards to wall surfaces with [egg-size] <Insert coverage> adhesive gobs at 16 inches (400 mm) o.c., horizontally and vertically.
- B. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches (400 mm) o.c. Secure both top and bottom of boards to walls.
 1. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than 24 inches (610 mm) o.c.
 - a. Attach chalktrays to boards with fasteners at not more than 12 inches (300 mm) o.c.
 2. Field-Applied Wood Trim: Install trim according to requirements in Division 06 Section "[Finish Carpentry] [Interior Architectural Woodwork]."

3.6 INSTALLATION OF VISUAL DISPLAY RAILS

- A. Display Rails: Install rails in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than 16 inches (400 mm) o.c.

1. Mounting Height: [48 inches (1219 mm)] [60 inches (1524 mm)] <Insert dimension> above finished floor to top of rail.

3.7 INSTALLATION OF VISUAL DISPLAY WALL PANELS

- A. Marker Wall Sheets: Attach wall sheets to wall surface with thin layer of adhesive over entire wall surface. Butt join adjacent panels [**and cover joint with matching joint strip installed with double-stick tape**].
- B. Marker Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at 16 inches (400 mm) o.c., horizontally and vertically.
 1. Join adjacent wall panels with concealed steel splines for smooth alignment.
 2. Join adjacent wall panels with exposed, H-shaped aluminum trim painted to match wall panel.
- C. Tack Wall Panels: Attach panels to wall surface with egg-size adhesive gobs at 16 inches (400 mm) o.c. horizontally and vertically.
 1. Install wrapped-edge wall panels with butt joints between adjacent wall panels.
 2. Join adjacent wall panels with exposed, H-shaped aluminum trim covered with same fabric as wall panels.

3.8 INSTALLATION OF [RAIL] [MODULAR] SUPPORT SYSTEM

- A. Rail Support System: Install horizontal support rail in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at 12 inches (300 mm) o.c.
 1. Mounting Height: [72 inches (1829 mm)] <Insert dimension> above finished floor to top of rail.
 2. Hang visual display units on rail support system.
- B. Modular Support System: Install adjustable standards in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Install standards at 48 inches (1219 mm) o.c., vertically aligned and plumb, and attached to wall surface with fasteners at 12 inches (300 mm) o.c.
 1. Mounting Height: [12 inches (300 mm)] <Insert dimension> above finished floor to bottom of standard.
 2. Install single-slotted standard at each end of each run of standards and double-slotted standards at intermediate locations.
 3. Provide locking screw at top corner of visual display board at each standard.
 4. Hang visual display units on modular support system.

3.9 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY UNITS

- A. Sliding Visual Display Units: Install units in recessed locations and at mounting heights indicated. Attach to wall framing with fasteners at not more than 16 inches (400 mm) o.c.
 1. Adjust panels to operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

- B. Visual Display Conference Units: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with **[fasteners through back of cabinet] [concealed brackets screwed to wall] [concealed wood cleats screwed to wall]**.
1. Mounting Height: **[72 inches (1829 mm)]** <Insert dimension> above finished floor to top of cabinet.

3.10 INSTALLATION OF VISUAL DISPLAY WALL COVERING

- A. Install visual display wall covering according to requirements specified in Division 09 Section "Wall Coverings."
- B. General: Comply with visual display wall covering manufacturers' written installation instructions.
- C. Install seams horizontal and level, with lowest seam **[24 inches (610 mm)]** <Insert dimension> above finished floor. Railroad fabric (reverse roll direction) to ensure color matching.
- D. Double cut seams, with no gaps or overlaps. Remove air bubbles, wrinkles, blisters, and other defects.
- E. After installation, clean visual display wall covering according to manufacturer's written instructions. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

3.11 INSTALLATION OF VISUAL ELECTRONIC MARKERBOARDS

- A. Electronic Markerboards: Install units in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to **[wall] [cubicle]** surface with manufacturer's standard mounting hardware.
1. Mounting Height: **[72 inches (1829 mm)]** <Insert dimension> above finished floor to top of markerboard.

3.12 CLEANING AND PROTECTION

- A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display surfaces after installation and cleaning.

3.13 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain motor-operated, sliding visual display units.

END OF SECTION 101100

SECTION 10 14 00 - SIGNAGE

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 the following:

1. Plaques.
2. Dimensional illuminated and non-illuminated characters.
3. Panel signs.
4. Illuminated panel signs.
5. Photoluminescent signs.

- B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary Project identification signs and for temporary information and directional signs.
2. Division 10 Section "Directories" for building directories.
3. Division 10 Section "Post and Panel/Pylon Signage" for freestanding signs.
4. Division 14 Section "Hydraulic Elevators" for code-required elevator signage.
5. Division 22 Section "Identification for Plumbing Piping and Equipment for labels, tags, and nameplates for plumbing systems and equipment.
6. Division 23 Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
7. Division 26 Sections for electrical service and connections for illuminated signs.
8. Division 26 Section "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
9. Division 26 Section "Interior Lighting" for illuminated Exit signs.

1.3 DEFINITIONS

- A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for signs.
 1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.

2. Provide message list, timesteps, graphic elements, including tactile characters and Braille, and layout for each sign.
 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Verification: For each of the following products and for the full range of color, texture, and sign material indicated, of sizes indicated:
1. Plaque Casting: 6 inches (150 mm) square including border.
 2. Dimensional Characters: Full-size Samples of each type of dimensional character (letter, number, and graphic element).
 3. Aluminum: For each form, finish, and color, on 6-inch- (150-mm-) long sections of extrusions and squares of sheet at least 4 by 4 inches (100 by 100 mm).
 4. Acrylic Sheet: 8 by 10 inches (200 by 250 mm) for each color required.
 5. Polycarbonate Sheet: 8 by 10 inches (200 by 250 mm) for each color required.
 6. Fiberglass Sheet: 8 by 10 inches (200 by 250 mm) for each color required.
 7. Panel Signs: Not less than 12 inches (305 mm) square including border.
 8. Photoluminescent Signs: Full-size sign.
 9. Trim and Frame: 6-inch- (152-mm-) long sections of each profile.
 10. Accessories: Manufacturer's full-size unit.
- D. Sign Schedule: Use same designations indicated on Drawings.
- 1.5 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer.
 - B. Warranty: Special warranty specified in this Section.
- 1.6 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For signs to include in maintenance manuals.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications: Fabricator of products.
 - B. Fabricator Qualifications: Shop that 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.
 - C. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.
 - D. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines, ICC/ANSI A117.1 and State Building Code Requirements.
 - E. 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.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 COORDINATION

- A. Coordinate placement of anchorage devices with templates for installing signs.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which 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 metal and polymer finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image colors and sign lamination.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M, of alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.
- B. Aluminum Sheet and Plate: **ASTM B 209** (**ASTM B 209M**), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.
- C. Aluminum Extrusions: **ASTM B 221** (**ASTM B 221M**), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.
- D. Brass Castings: ASTM B 584, Alloy UNS No. C85200 (high-copper yellow brass).
- E. Brass, Yellow, Sheet: ASTM B 36/B 36M, Alloy UNS No. C26000.
- F. Bronze Castings: ASTM B 584, Alloy UNS No. C86500 (No. 1 manganese bronze).
- G. Bronze Plate: ASTM B 36/B 36M.
- H. Copper Sheet: ASTM B 152/B 152M.

- I. Steel:
1. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, either commercial or forming steel.
 2. Steel Sheet: Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, Type B, exposed or electrolytic zinc-coated, ASTM A 591/A 591M, with steel sheet substrate complying with ASTM A 1008/A 1008M, commercial steel, exposed.
 3. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 316, stretcher-leveled standard of flatness.
 4. Steel Members Fabricated from Plate or Bar Stock: ASTM A 529/A 529M or ASTM A 572/A 572M, 42,000-psi (290-MPa) minimum yield strength.
 5. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.
- J. Fiberglass Sheet: Molded, seamless, thermosetting, glass-fiber-reinforced polyester panels with a minimum tensile strength of 15,000 psi (103 MPa) when tested according to ASTM D 638 and with a minimum flexural strength of 30,000 psi (207 MPa) when tested according to ASTM D 790.
- K. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
- L. Polycarbonate Sheet: Of thickness indicated, manufactured by extrusion process, coated on both surfaces with abrasion-resistant coating:
1. Impact Resistance: 16 ft-lbf/in. (854 J/m) per ASTM D 256, Method A.
 2. Tensile Strength: 9000 lbf/sq. in. (62 MPa) per ASTM D 638.
 3. Flexural Modulus of Elasticity: 340,000 lbf/sq. in. (2345 MPa) per ASTM D 790.
 4. Heat Deflection: 265 deg F (129 deg C) at 264 lbf/sq. in. (1.82 MPa) per ASTM D 648.
 5. Abrasion Resistance: 1.5 percent maximum haze increase for 100 revolutions of a Taber abraser with a load of 500 g per ASTM D 1044.
- M. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing, suitable for exterior applications.

2.2 PLAQUES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide **[the product indicated on Drawings]** <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
1. Advance Corporation; Braille-Tac Division.
 2. A. R. K. Ramos.
 3. Gemini Incorporated.
 4. Matthews International Corporation; Bronze Division.
 5. Metal Arts; Div. of L&H Mfg. Co.
 6. Mills Manufacturing Company.
 7. Nelson-Harkins Industries.

8. Southwell Company (The).
9. <Insert manufacturer's name.>

D. Cast Plaques: Provide castings free of pits, scale, sand holes, and other defects, as follows:

1. Plaque Material: [Aluminum] [Bronze].
2. Background Texture: Manufacturer's standard [pebble] [leatherette] [matte] [stipple] <Insert description> texture.
3. Border Style: [Square, polished] [Plain bevel] [Projected bevel] [Raised flat band] [Double-raised line border] <Insert description>.
4. Mounting: [Rosettes and fasteners matching plaque finish] [Concealed studs][, noncorroding] for substrates encountered.

E. Etched Plaques: Provide metal sheet or plate for etching, as follows:

1. Plaque Material: [Aluminum] [Brass] [Bronze] <Insert material>.
2. Custom Paint Colors: Match [Pantone] <Insert system> color matching system.
3. Color(s): [As indicated] [As selected by Architect from manufacturer's full range] <Insert color(s)>.
4. Edge Style: [Square, polished] [Plain bevel].
5. Mounting: [Concealed studs] [Exposed fasteners][, noncorroding] for substrates encountered.
6. Thickness: [0.125 inch (3.18 mm)] [0.250 inch (6.35 mm)] <Insert dimension> thick.

F. Plaque Schedule:

1. Plaque Type <Insert designation>:
 - a. Plaque Size: [As indicated] <Insert dimensions>.
 - b. Character Size: [As indicated] <Insert size>.
 - c. Character Finish/Color: <Insert finish/color.>
 - d. Text/Message: [As indicated] <Insert text/message>.
 - e. Location: [As indicated] <Insert designation>.
 - f. Room: <Insert designation.>
 - g. Quantity: <Insert number.>

2.3 DIMENSIONAL CHARACTERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:

1. ACE Sign Systems, Inc.
2. Advance Corporation; Braille-Tac Division.
3. A. R. K. Ramos.
4. ASI-Modulex, Inc.
5. Bunting Graphics, Inc.
6. Charleston Industries, Inc.

7. Gemini Incorporated.
 8. Grimco, Inc.
 9. Innerface Sign Systems, Inc.
 10. Metal Arts; Div. of L&H Mfg. Co.
 11. Mills Manufacturing Company.
 12. Mohawk Sign Systems.
 13. Nelson-Harkins Industries.
 14. Signature Signs, Incorporated.
 15. Southwell Company (The).
 16. **<Insert manufacturer's name.>**
- D. Cast Characters: Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated. Comply with the following requirements.
1. Character Material: **[Aluminum] [Brass] [Bronze] <Insert material>**.
 2. Thickness: **[As indicated] <Insert dimension>**.
 3. Color(s): **[As indicated] [As selected by Architect from manufacturer's full range] <Insert color(s)>**.
 4. Mounting: **[Rosettes and fasteners matching character finish] [Concealed studs][, noncorroding]** for substrates encountered.
- E. Aluminum Extrusions: Comply with the following requirements:
1. Finish: **[Anodized] [Painted] <Insert description>**.
 2. Thickness: **[As indicated] <Insert dimension>**.
 3. Custom Paint Colors: Match **[Pantone] <Insert system>** color matching system.
 4. Color(s): **[As indicated] [As selected by Architect from manufacturer's full range] <Insert color(s)>**.
 5. Mounting: Concealed studs[, **noncorroding**] for substrates encountered.
- F. Fabricated Channel Characters: Form exposed faces and sides of characters to produce surfaces free from warp and distortion. Include internal bracing for stability and attachment of mounting accessories. Comply with the following requirements:
1. Illuminated **[Backlighted] [Frontlighted]** Channel Characters: Manufacturer's standard **[fluorescent tube] [fiber-optic] [LED] [neon tube]** lighting including transformers, insulators, and other components. Make provisions for servicing and concealing connections to building electrical system.
 2. Aluminum Sheet: Not less than **0.090 inch (2.29 mm)** thick.
 - a. Finish: **[Anodized] [Painted] <Insert description>**.
 - b. Custom Paint Colors: Match **[Pantone] <Insert system>** color matching system.
 - c. Color: **[As indicated] [As selected by Architect from manufacturer's full range] <Insert color>**.
 3. Bronze Sheet: Not less than **[0.032 inch (0.81 mm)] <Insert dimension>** thick.
 4. Brass Sheet: Not less than **[0.032 inch (0.81 mm)] <Insert dimension>** thick.
 5. Copper Sheet: Not less than **[0.032 inch (0.81 mm)] [0.048 inch (1.22 mm)] <Insert dimension>** thick.
 6. Steel Sheet: Painted, not less than **0.050 inch (1.27 mm)** thick for face and **0.031 inch (0.78 mm)** thick for returns.

- a. Color: **[As indicated]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
7. Stainless-Steel Sheet: Not less than **0.050 inch (1.27 mm)** thick for face and **0.031 inch (0.78 mm)** thick for returns.
- a. Finish: **[No. 4]** **[No. 8]** <Insert description>.
8. <Insert material and thickness.>
9. Provide manufacturer's hardware for projection mounting of **[backlighted]** channel characters at <Insert dimension> distance from wall surface **[indicated]**.
10. Provide translucent acrylic face sheet of thickness indicated. Attach characters to sheet metal back channels. Provide required to illuminate sign faces evenly.
- a. Color: **[As indicated]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
11. Provide open-front, sheet metal channel characters.
- G. Molded Plastic Characters: **[Thermoformed]** **[Injection molded]** and as follows:
- 1. Illuminated Characters: Manufacturer's standard **[fluorescent tube]** **[fiber-optic]** **[LED]** **[neon tube]** lighting including transformers, insulators, and other components. Make provisions for servicing and concealing connections to building electrical system.
 - 2. **[Integral Color]** **[Painted Finish]**: **[As indicated]** **[As selected by Architect from manufacturer's full range]** <Insert color or finish>.
- H. Cutout Characters: Provide characters with square-cut, smooth **[eased]** edges. Comply with the following requirements:
- 1. Acrylic: **[0.25 inch (6.35 mm)]** **[0.50 inch (12.7 mm)]** <Insert dimension> thick.
 - a. Metal face laminated to acrylic base **[with painted edges]**.
 - 1) Brass Face: **[Satin]** **[Polished]** <Insert description> finish.
 - 2) Stainless-Steel Face: **[No. 4]** **[No. 8]** <Insert description> finish.
 - 3) Metal Thickness: **[0.030 inch (0.76 mm)]** <Insert dimension>.
 - b. Custom Paint Colors: Match **[Pantone]** <Insert system> color matching system.
 - c. Color: **[As indicated]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
 - 2. Aluminum Sheet: **[0.125 inch (3.18 mm)]** **[0.25 inch (6.35 mm)]** <Insert dimension> thick.
 - a. Finish: **[Anodized]** **[Painted]** <Insert description>.
 - b. Custom Paint Colors: Match **[Pantone]** <Insert system> color matching system.
 - c. Color: **[As indicated]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
 - 3. Brass Sheet, Yellow: **[0.125 inch (3.18 mm)]** **[0.25 inch (6.35 mm)]** <Insert dimension> thick.
 - 4. Bronze Sheet: **[0.125 inch (3.18 mm)]** **[0.25 inch (6.35 mm)]** <Insert dimension> thick.
 - 5. Vinyl: Pressure sensitive, **[3.5 mils (0.09 mm)]** <Insert dimension> thick.

- a. Custom Paint Colors: Match **[Pantone]** <Insert system> color matching system.
 - b. Color: **[As indicated]** **[As selected by Architect from manufacturer's full range]** <Insert color>.
6. <Insert material.>
 7. Mounting: **[Adhesive]** **[Flush]** **[Projected]** **[Back bar]** **[Bracket]** <Insert description>**[with concealed noncorroding studs]** for substrates encountered.
- I. Dimensional Character Sign Schedule:
1. Sign Type <Insert designation>:
 - a. Sign Size: **[As indicated]** <Insert dimensions>.
 - b. Character Size: **[As indicated]** <Insert size>.
 - c. Text/Message: **[As indicated]** <Insert text/message>.
 - d. Location: **[As indicated]** <Insert designation>.
 - e. Room: <Insert designation.>

2.4 PANEL SIGNS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide **[the product indicated on Drawings]** <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
 1. ACE Sign Systems, Inc.
 2. Advance Corporation; Braille-Tac Division.
 3. Allen Industries Architectural Signage
 4. Allenite Signs; Allen Marking Products, Inc.
 5. APCO Graphics, Inc.
 6. ASI-Modulex, Inc.
 7. Best Sign Systems Inc.
 8. Bunting Graphics, Inc.
 9. Fossil Industries, Inc.
 10. Gemini Incorporated.
 11. Grimco, Inc.
 12. Innerface Sign Systems, Inc.
 13. InPro Corporation
 14. Matthews International Corporation; Bronze Division.
 15. Mills Manufacturing Company.
 16. Mohawk Sign Systems.
 17. Nelson-Harkins Industries.
 18. Seton Identification Products.
 19. Signature Signs, Incorporated.
 20. Supersine Company (The)
 21. <Insert manufacturer's name.>

- D. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus **1/16 inch (1.5 mm)** measured diagonally from corner to corner, complying with the following requirements:
1. Aluminum Sheet: **[0.050 inch (1.27 mm)] [0.080 inch (2.03 mm)]** <Insert dimension> thick.
 2. Laminated, Aluminum-Faced Sheet: **[0.020-inch- (0.51-mm-)]** <Insert dimension> thick aluminum sheet laminated to each side of **[0.197-inch- (5.0-mm-)] [0.394-inch- (10.0-mm-)]** <Insert dimension> thick, **[corrugated] [phenolic] [acrylic]** backing**[with painted edges]**.
 3. Laminated, Polycarbonate-Faced Sheet: **[0.060-inch- (1.52-mm-)]** <Insert dimension> thick, polycarbonate face sheet laminated to each side of **[0.197-inch- (5.0-mm)] [0.394-inch- (10.0-mm-)]** <Insert dimension> thick phenolic backing.
 4. Acrylic Sheet: **[0.060 inch (1.52 mm)] [0.080 inch (2.03 mm)]** <Insert dimension> thick.
 5. PVC Sheet: **[0.060-inch- (1.52-mm-)] [0.080-inch- (2.03-mm-)]** <Insert dimension> thick, extruded, high-impact PVC plastic **[in color to match face color] [with painted finish]**.
 6. High-Pressure Decorative Laminate: **0.048 inch (1.21 mm)** thick.
 7. Phenolic-Backed Photopolymer Sheet: Provide light-sensitive, water-wash photopolymer face layer bonded to a phenolic base layer to produce a composite sheet with overall, face layer, and base-layer thicknesses, respectively, of **[0.120, 0.040, and 0.080 inch (3.0, 1.0, and 2.03 mm)] [0.160, 0.040, and 0.120 inch (4.06, 1.0, and 3.04 mm)]**.
 8. Laminated Sheet: High-pressure engraved stock with**[contrasting color]** face laminated to acrylic core **[in finishes and color combinations indicated] [as selected by Architect from manufacturer's full range]**.
 9. Laminated, Etched Photopolymer: Raised graphics**[with Braille] 1/32 inch (0.8 mm)** above surface with contrasting colors **[in finishes and color combinations indicated] [as selected by Architect from manufacturer's full range]** and laminated to acrylic back.
 10. Laminated, Sandblasted Polymer: Raised graphics**[with Braille] 1/32 inch (0.8 mm)** above surface with contrasting colors **[in finishes and color combinations indicated] [as selected by Architect from manufacturer's full range]** and laminated to acrylic back.
 11. Edge Condition: **[Square cut] [Beveled] [Bullnose]**.
 12. Corner Condition: **[Square] [Rounded to radius indicated]**.
 13. Mounting: **[Framed] [Unframed] [As indicated]**.
 - a. **[Wall] [Ceiling] [Projection]** mounted with **[concealed anchors] [magnetic tape] [two-face tape]**.
 - b. Manufacturer's standard anchors for substrates encountered.
 14. Custom Paint Colors: Match **[Pantone]** <Insert system> color matching system.
 15. Color: **[As indicated] [As selected by Architect from manufacturer's full range]** <Insert color>.
 16. Tactile Characters: Characters and Grade 2 Braille raised **1/32 inch (0.8 mm)** above surface with contrasting colors.
- E. Exterior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus **1/16 inch (1.5 mm)** measured diagonally from corner to corner, complying with the following requirements:
1. Aluminum Sheet: **[0.050 inch (1.27 mm)] [0.080 inch (2.03 mm)]** <Insert dimension> thick.
 2. Laminated, Aluminum-Faced Sheet: **[0.020-inch- (0.51-mm-)]** <Insert dimension> thick aluminum sheet laminated to each side of **[0.197-inch- (5.0-mm-)] [0.394-inch- (10.0-**

- mm-)] <Insert dimension> thick, [corrugated] [phenolic] [acrylic] backing[with painted edges].**
3. Acrylic Sheet: **[0.060 inch (1.52 mm)] [0.080 inch (2.03 mm)] <Insert dimension> thick.**
 4. Fiberglass Sheet: **[0.090-inch- (2.29-mm-)] [0.125-inch- (3.18-mm-)] <Insert dimension> thick sheet.**
 5. Edge Condition: **[Square cut] [Beveled] [Bullnose].**
 6. Corner Condition: **[Square] [Rounded to radius indicated].**
 7. Mounting: **[Framed] [Unframed] [As indicated].**
 - a. **[Wall] [Soffit] [Projection] mounted.**
 - b. **Manufacturer's standard[noncorroding] anchors for substrates encountered.**
 8. Custom Paint Colors: Match **[Pantone] <Insert system> color matching system.**
 9. Color: **[As indicated] [As selected by Architect from manufacturer's full range] <Insert color>.**
- F. Laminated **[Interior] [Exterior] Signs: Solid phenolic panel core with graphic image covered with thermosetting resin face layer.**
1. Surface Finish: **[Mat] [Beaded] [Gloss] [UV resistant, outdoor].**
 2. Edge Condition: **[Square cut] [Beveled] [Bullnose].**
 3. Corner Condition: **[Square] [Rounded to radius indicated].**
 4. Thickness: **[1/8 inch (3 mm)] [1/4 inch (6 mm)] <Insert dimension>.**
- G. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory paint brackets in color **[matching background color of panel sign] [matching Architect's sample] <Insert color>.**
- H. Panel Sign Frames:
1. PVC Frames: Extruded, high-impact PVC plastic.
 - a. Color: **[As indicated] [As selected by Architect from manufacturer's full range] [Match face color] <Insert color>.**
 - b. Depth: **[As indicated] <Insert dimension>.**
 - c. Profile: **[Square] [Beveled] [Rounded].**
 - d. Corner Condition: **[Square] [Rounded to radius indicated].**
 - e. Mounting: As indicated.
 - 1) **[Wall] [Ceiling] [Projection] mounted with [concealed anchors] [magnetic tape] [two-face tape].**
 - 2) **Manufacturer's standard[noncorroding] anchors for substrates encountered.**
 2. Extruded-Aluminum Frames: Mitered **[with concealed anchors] [and welded].**
 - a. Color: **[As indicated] [As selected by Architect from manufacturer's full range] <Insert color>.**
 - b. Depth: **[As indicated] <Insert dimension>.**
 - c. Profile: **[Square] [Beveled] [Rounded].**
 - d. Corner Condition: **[Square] [Rounded to radius indicated].**
 - e. Mounting: As indicated.

- 1) **[Wall] [Ceiling] [Projection]** mounted with **[concealed anchors] [magnetic tape] [two-face tape]**.
 - 2) Manufacturer's standard **[noncorroding]** anchors for substrates encountered.
3. Metal Frames:
- a. Bronze Plate: Not less than **0.032 inch (0.81 mm)** thick.
 - b. Brass Plate: Not less than **0.032 inch (0.81 mm)** thick.
 - c. Steel Sheet: Painted, not less than **0.050 inch (1.27 mm)** thick for face and **0.031 inch (0.78 mm)** thick for returns.
 - 1) Color: **[As indicated] [As selected by Architect from manufacturer's full range] <Insert color>**.
 - d. Stainless-Steel Sheet: Not less than **0.050 inch (1.27 mm)** thick for face and **0.031 inch (0.78 mm)** thick for returns.
 - e. **<Insert material and thickness>**.
 - f. Depth: **[As indicated] <Insert dimension>**.
 - g. Corner Condition: **[Square] [Rounded to radius indicated]**.
 - h. Mounting: As indicated.
 - 1) **[Wall] [Ceiling] [Projection]** mounted with **[concealed anchors] [magnetic tape] [two-face tape]**.
 - 2) Manufacturer's standard **[noncorroding]** anchors for substrates encountered.
- I. Changeable Message Inserts: Fabricate signs to allow insertion of changeable messages in the form of **[slide-in inserts] [transparent covers with paper inserts printed by Owner] [changeable panel inserts for use in fixed frames] <Insert description>**.
1. Furnish insert material and software for creating text and symbols for **[PC-Windows] [Macintosh]** computers for Owner production of paper inserts.
 2. Furnish insert material cut-to-size for changeable message insert.
- J. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.
1. Panel Material: **[Opaque acrylic sheet] [Photopolymer] [Clear acrylic sheet with opaque color coating, subsurface applied]**.
 2. Raised-Copy Thickness: Not less than **1/32 inch (0.8 mm)**.
- K. Engraved Copy: Machine engrave letters, numbers, symbols, and other graphic devices into panel sign on face indicated to produce precisely formed copy, incised to uniform depth.
1. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.
 2. Engraved Metal: Fill engraved copy with enamel.
 3. Engraved Opaque Acrylic Sheet: Fill engraved copy with enamel.
 4. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with enamel. Apply opaque background color coating to back face of acrylic sheet.

- L. Subsurface Copy: Apply minimum **4-mil- (0.10-mm-)** thick vinyl copy to back face of clear acrylic sheet forming panel face to produce precisely formed opaque image. Image shall be free of rough edges.
- M. Subsurface Engraved Acrylic Sheet: Reverse-engage back face of clear acrylic sheet. Fill resulting copy with enamel. Apply opaque background color coating over enamel-filled copy.
- N. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of **3 mils (0.076 mm)** with pressure-sensitive adhesive backing. Apply copy to **[exposed face of panel sign] [glass] [doors] [wall surfaces] <Insert substrate>**.
 - 1. Panel Material: **[Opaque acrylic sheet] [Clear acrylic sheet with opaque color coating, subsurface applied]**.
- O. Colored Coatings for Acrylic Sheet: For copy **[and] [background] [and frame]** colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are UV and water resistant for **[three] [five]** years for application intended.
 - 1. Custom Paint Colors: Match **[Pantone] <Insert system>** color matching system.
 - 2. Color: **[As indicated] [As selected by Architect from manufacturer's full range] <Insert color>**.
- P. Panel Sign Schedule:
 - 1. Sign Type **<Insert designation>**:
 - a. Sign Size: **[As indicated] <Insert dimensions>**.
 - b. Message Panel Material: **[As indicated] <Insert material>**.
 - c. Message Panel Finish/Color: **<Insert finish/color.>**
 - d. Background Finish/Color: **<Insert finish/color.>**
 - e. Character Size: **[As indicated] <Insert size>**.
 - f. Character Finish/Color: **<Insert finish/color.>**
 - g. Panel Sign Frame Finish/Color: **<Insert finish/color.>**
 - h. Text/Message: **[As indicated] <Insert text/message>**.
 - i. Location: **[As indicated] <Insert designation>**.
 - j. Room: **<Insert designation.>**
 - k. Quantity: **<Insert number.>**

2.5 PHOTOLUMINESCENT SIGNS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide **[the product indicated on Drawings] <Insert manufacturer's name; product name or designation>** or a comparable product by one of the following:
 - 1. Evenlite Inc.
 - 2. Holophane Corporation.
 - 3. Isolite Corporation.

4. Johnsonite; Division of Duramax, Inc.
5. <Insert manufacturer's name.>

D. Photoluminescent Signs: Self-contained, [single] [double] face, as follows:

1. Manufacturer's standard [aluminum] [plastic] frame with translucent lettering and transparent polycarbonate face.
2. Exit sign, UL 924.
3. Mounting: As indicated.
 - a. [Wall] [Ceiling] [Projection] mounted with concealed anchors.
4. Face Color: [Red] [Green] [Black].
5. Frame Color: [As indicated] [As selected by Architect from manufacturer's full range] <Insert color>.
6. Service Life: [10] [15] [20] years.

E. Photoluminescent Sign Schedule:

1. Sign Type <Insert designation>:
 - a. Location: [As indicated] <Insert designation>.
 - b. Room: <Insert designation>.
 - c. Quantity: <Insert quantity>.

2.6 ACCESSORIES

- A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.7 FABRICATION

A. General: Provide manufacturer's standard signs of configurations indicated.

1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.8 FINISHES, GENERAL

- 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: 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 the 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.

2.9 ALUMINUM FINISHES

- A. Clear Anodic Finish: Manufacturer's standard Class 1 clear anodic coating, 0.018 mm or thicker, over a satin (directionally textured) or polished (buffed) mechanical finish unless indicated otherwise, complying with AAMA 611.
- B. Color Anodic Finish: Manufacturer's standard Class 1 integrally colored or electrolytically deposited color anodic coating, 0.018 mm or thicker, color as indicated, applied over a satin (directionally textured) mechanical finish, complying with AAMA 611.
- C. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - 1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.

2.10 STEEL FINISHES

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
- B. Factory Priming for Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.
 - 1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- C. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).

2.11 STAINLESS-STEEL FINISHES

- A. 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.

- B. Directional Satin Finish: No. 4 finish.
- C. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.12 COPPER-ALLOY FINISHES

- A. Sheet or Plate Finish: [Medium satin (directionally textured)] [Smooth specular (mirrorlike), buffed] finish.
 - 1. Raised Finish: [**Satin**] [**Polished**] [**Painted**] <Insert description>.
 - 2. Recessed Finish: Etched[, **Painted**] <Insert description>.
- B. Cast-**Bronze**] [**Brass**] Character Finishes: Manufacturer's [**standard satin finish**] <Insert description> with exposed surfaces free from porosity, burrs, and rough spots; with returns finished with fine-grain air blast.
- C. Cast-Bronze Plaque Finishes: Exposed surfaces free of porosity, burrs, and rough spots; with returns finished with fine-grain air blast.
 - 1. Raised Areas: Hand-tool and buff borders and raised copy to produce manufacturer's standard [**satin**] [**polished**] finish.
 - 2. Background Finish: [**Painted**] [**Dark oxidized**] [**Green patina**] <Insert description>.
- D. Clear Protective Coating: Coat exposed surfaces of copper alloys with manufacturer's standard, clear organic coating specially designed for coating copper-alloy products.

2.13 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

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 work.
- B. Verify that items, including anchor inserts, and electrical power are sized and located to accommodate signs.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within **3 inches (75 mm)** of sign without encountering protruding objects or standing within swing of door.
- B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
 2. Hook-and-Loop Tapes: Mount signs to smooth, nonporous surfaces.
 3. Magnetic Tape: Mount signs to smooth, nonporous surfaces.
 4. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
 5. Shim Plate Mounting: Provide **1/8-inch- (3-mm-)** thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
 6. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
 7. Signs Mounted on Glass: Provide matching opaque plate on opposite side of glass to conceal mounting materials.
- C. Bracket-Mounted Signs: Provide manufacturer's standard brackets, fittings, and hardware for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls and ceilings with concealed fasteners and anchoring devices to comply with manufacturer's written instructions.
- D. Dimensional Characters: Mount characters using standard fastening methods to comply with manufacturer's written instructions for character form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish character spacing and to locate holes for fasteners.
1. Flush Mounting: Mount characters with backs in contact with wall surface.
 2. Projected Mounting: Mount characters at projection distance from wall surface indicated.
- E. Cast-Metal Plaques: Mount plaques using standard fastening methods to comply with manufacturer's written instructions for type of wall surface indicated.
1. Concealed Mounting: Mount plaques by inserting threaded studs into tapped lugs on back of plaque. Set in predrilled holes filled with quick-setting cement.
 2. Face Mounting: Mount plaques using exposed fasteners with rosettes attached through face of plaque into wall surface.

3.3 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

3.4 SCHEDULE OF SIGNAGE

- A. At the minimum the following signs shall be required:
- B. Room (Suites) names and numbers with ID slide-ins, Braille. (Approx. 8" x 8")
- C. Area Signage, with room name and number, Braille (Approx. 8" x 8")
- D. Office Signage, individual name and room number, Braille (Approx. 8" x 4")
- E. Dedicatory Plaque (Nominal 24" x 36").
- F. Evacuation Plans (At elevators each floor, each office, lab, suite).
- G. Exterior Signage (Site Drawings)
- H. Egress ID (In stairs per RISBC-1)
- I. Cast Letters
- J. Directional Signage

END OF SECTION 10 14 00

SECTION 11 13 13 – Permanent Guard Rails

PART 1 - GENERAL

SCHEDULE 0 - SECTION INCLUDES

PRODUCT DATA SHEET 0 - Permanent railing system for elevated platform fall protection.

SCHEDULE 1 - REFERENCES

- A. Occupational Safety & Health Administration (OSHA):
1. 29 CFR 1910.28(b) – Duty to Have Fall Protection and Falling Object Protection
 2. 29 CFR 1910.29(b) – Fall Protection Systems and Falling Object Protection-
criteria and practices.
 3. 29 CFR 1910.23 – Walking-Working Surfaces - Fixed Ladders.
 4. 29 CFR 1926.500 - Scope, Application, Definitions Applicable to this Subpart.
 5. 29 CFR 1926.501 - Duty to Have Fall Protection.
 6. 29 CFR 1926.502 - Fall Protection Systems Criteria and Practices.
 7. 29 CFR 1926.503 - Training Requirements.
 8. American National Standards Institute (ANSI): ANSI A14.3 - American National Standards
for Ladders - Fixed - Safety Requirements
 9. American Welding Society: AWS D1.1 - Structural Welding Code - Steel.
 10. American Welding Society: AWS D1.3 - Structural Welding Code - Sheet Steel.

SCHEDULE 2 - SUBMITTALS

PRODUCT DATA SHEET 0 - Submit under provisions of Section 01 30 00 - Administrative Re-
quirements.

PRODUCT DATA SHEET 1 - Manufacturer's data sheets on each product to be used, includ-
ing:

- 1.1 Preparation instructions and recommendations.
- 1.2 Storage and handling requirements and recommendations.
- 1.3 Installation methods.

PRODUCT DATA SHEET 2 - Shop Drawings: Drawings showing plans, elevations, sections and
details of components.

PRODUCT DATA SHEET 3 - Manufacturer's Certificates:

- 1.1 Certify that Railings and Base Castings are made in USA. Provide steel mill and
foundry certificates for verification prior to shipment.
- 1.2 Manufacturer must be American Welding Society Welding Certified for Welding
Standards AWS D1.1 & AWS D1.3. Third party qualification documentation required
prior to shipment.

SCHEDULE 3 - DELIVERY, STORAGE, AND HANDLING

PRODUCT DATA SHEET 0 - Deliver materials to the job site in good condition and adequately protected against damage as handrails are a finished product.

PRODUCT DATA SHEET 1 - Inspect rail sections for damage before signing the receipt from the trucking company. Truck driver must note damaged goods on the bill of lading if damaged product is found.

PRODUCT DATA SHEET 2 - Store products in manufacturer's unopened packaging until ready for installation.

SCHEDULE 4 - PROJECT CONDITIONS

PRODUCT DATA SHEET 0 - Field Measurements: Where handrails and railings are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication.

SCHEDULE 5 - WARRANTY

PRODUCT DATA SHEET 0 - Warranty: Provide manufacture's two (2) year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

PRODUCT DATA SHEET 0 - Basis of Design: Safety Rail Company, LLC. which is located at: 4244 Shoreline Drive, Spring Park, MN 55384; Toll Free Tel: 888-434-2720; Tel: 952-594-3508; Fax: 888-471-4931; Email: sales@safetyrailcompany.com; Web: www.safetyrailcompany.com

PRODUCT DATA SHEET 1 - ULINE which is located at: 12575 Uline Drive, Pleasant Prairie, WI 53158; Toll Free Tel: 1-800-295-5510; Email: customerservice@uline.com; Web: uline.com

PRODUCT DATA SHEET 2 - EFP (Engineered Fall Protection): Tel; (314) 492-4422; Email; sales@engineeredfallprotection.com; Web; engineeredfallprotection.com

PRODUCT DATA SHEET 3 - KEE Safety: Tel; 1 (866) 533-1429; Web; keesafety.com

PRODUCT DATA SHEET 4 - Substitutions: Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

SCHEDULE 1 - SYSTEMS

- 1) Elevated Platform Fall Protection: Provide permanent pedestrian barrier system, including railings, mounts and safety connector pins.
 - a) Basis of Design Product: SRC Permanent Safety Rail System
 - b) Standards: System shall have top and mid rail in accordance with OSHA Standards - 29 CFR 1910.29 (b).
 - c) Structural Load: 200 lb (90.7 kg), minimum, in any direction to all components in accordance with OSHA Regulation 29 CFR 1926.502.
 - d) Height: 42 inches (1067 mm), nominal above walking surface.
 - e) Railings: 1-5/8 inch (41 mm) O.D. hot rolled pickled electric weld tubing, free of sharp edges and snag points.
 - f) Mounting Style: Face Mount.

- 2) Mount Bracket Options:
 - a) Face Mount Bracket – bolted to vertical wall of pit, railings removable
 - b) Hardware: Securing pins shall be 1010 carbon steel, zinc plated and yellow chromate dipped. Pins shall consist of collared pin and latch.
 - c) Accessories: Toe Board Brackets – Provide brackets as manufactured by Safety Rail Company.
 - d) Product Origin: Railings and Bases are specified as 100% made in USA. Manufacturer must provide steel mill and foundry certificates for verification upon request.
 - e) Quality/Standards Certifications: Manufacturer must be American Welding Society welding qualified for Welding Standards AWS D1.1 & AWS D1.3 Third party qualification documentation required prior to shipment.

2.3 FINISHES

- A. Finish: Hot Dipped Zinc Galvanized
- B. Finish: Yellow Powder Coat, Std
- C. Color: Safety Yellow std; or match architect's sample

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- D. Install in accordance with manufacturer's instructions.

3.4 PROTECTION

- E. Protect installed products until completion of project.
- F. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Electric traction passenger elevators.

1.2 RELATED SECTIONS

- A. Section 015000 – Temporary Facilities and Controls: Protection of floor openings and personnel barriers; temporary power and lighting.
- B. Section 033000 – Cast-in-Place Concrete: Elevator pits.
- C. Section 036000 – Grouts (Grouting): Grouting door frames and sills.
- D. Section 042000 – Masonry Units (Unit Masonry): Setting sleeves, inserts, and anchoring devices in masonry for guide-rail brackets.
- E. Section 051200 – Metal Stairs Structural Steel (Structural Steel Framing): Support steel, divider beams, and hoist beams.
- F. Section 055000 – Gypsum Metal Fabrications: Pit ladders, supports for entrances in drywall hoistways.
- G. Section 061053 – Miscellaneous Rough Carpentry: Temporary platform assembly.
- H. Section 071600 – Cementitious Waterproofing: Waterproofing of elevator pit.
- I. Section 092900 – Gypsum Board: Hoistway walls.
- J. Section 099000 – Paints and Coatings (Painting and Coating): Field painting of elevator entrances over primer.
- K. Section 283100 – Detection and Alarm (Fire Detection and Alarm): Heat, smoke, and products of combustion sensing devices, fire alarm signal lines to contacts in machine space.
- L. Section 23000 – Heating, Ventilating, and Air Conditioning Equipment (Heating, Ventilating, and Air-Conditioning (HVAC)): Heating, cooling, and ventilation of control and machinery space.
- M. Section 260500 – Wiring Methods (Common Work Results for Electrical): Light outlets, convenience outlets, light switches, and conduits.
- N. Section 262400 – Switchboards, Panelboards, and Control Centers (Switchboards and Panelboards): Disconnect switches.
- O. Section 265000 – Lighting: Light fixtures.
- P. Section 221429 – Sump Pumps: For sump pumps, sumps, and sump covers in elevator pits.
- Q. Section 271500 – Communications Horizontal Cabling: For Telephone service for elevators and for Internet connection to elevator controllers for remote monitoring.
- R. Section 273000 – Telephone and Intercommunication Equipment (Voice Communications): Telephone outlets and elevator telephones.
- S. Section 31000 – Earthwork: Excavation of elevator pit.

1.3 REFERENCES

- A. ANSI/ASME A17.1/CAN/CSA B44 – Safety Code for Elevators and Escalators.
- B. ADAAG – Americans with Disabilities Act Accessibility Guidelines.
- C. ANSI/NFPA 70 – National Electrical Code.
- D. ANSI/NFPA 80 – Fire Doors and Windows.
- E. ANSI/UL 10B – Fire Tests of Door Assemblies.
- F. CAN/CSA C22.1 – Canadian Electrical Code.
- G. Model and Local Building Codes
- H. ISO 9001: 2000 - Quality Management Systems - Requirements.

1.4 DESIGN REQUIREMENTS

- A. Arrange elevator components in control closet or machinery space so equipment can be removed for repairs or replaced with minimal disturbance to other equipment and components.
- B. Where permitted by code, provide all elevator equipment including controls, drives, transformers, and rescue features within the elevator hoistway.

1.5 SUBMITTALS

- A. Comply with Section 013300 (01 33 00) – Submittal Procedures.
- B. Product Data: Submit manufacturer/installer's product data, including,
 - a. Descriptive brochures or detail drawings of car and hall fixtures, cab ceilings, and product features.
 - b. Power Information: Horsepower, starting current, running current, machine and control heat release, and electrical requirements.
- C. Shop Drawings: Submit manufacturer/installer's shop drawings, including plans, elevations, sections, and details, indicating location of equipment, loads, dimensions, tolerances, materials, components, fabrication, fasteners, hardware, finish, options, accessories, and other information to render totally functional elevators.
- D. Samples: Submit manufacturer/installer's samples of standard colors and finishes of finish materials.
- E. Operation and Maintenance Manual: Submit manufacturer/installer's operation and maintenance manual; including operation, maintenance, adjustment, and cleaning instructions; trouble shooting guide; renewal parts catalogs; and electrical wiring diagrams.
- F. Warranty: Submit manufacturer/installer's standard warranty.

1.6 QUALITY ASSURANCE

A. Manufacturer/Installer's Qualifications: Specialize in manufacturing and installing elevator equipment, with a minimum of 10 years successful experience.

B. Regulatory Requirements:

a. Elevator design, clearances, construction, workmanship, materials, and installation, unless specified otherwise, shall be in accordance with ANSI/ASME A17.1, handicap accessibility, Americans with Disabilities Act, and other codes having legal jurisdiction.

b. ANSI/ASME A17.1 shall govern, except where codes having legal jurisdiction include more rigid requirements or conflict with ANSI/ASME A17.1.

c. Elevator shall follow design and manufacturing procedures certified in accordance with ISO 9001-2000 to meet product and service requirements for quality assurance for new products.

d. Where product is in variance to the published ANSI/ASME A17.1 model code, provide a 3rd party AECO certification demonstrating equivalent function, safety, and performance.

C. Pre-installation Meeting:

a. Convene pre-installation meeting before start of installation of elevators.

b. Require attendance of parties directly affecting work of this section, including Contractor, Architect, and elevator manufacturer/installer.

c. Review examination, installation, field quality control, adjusting, cleaning, protection, and coordination with other work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer/installer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer/installer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer/installer's instructions.

C. Handling: Protect materials during handling and installation to prevent damage.

1.8 PROJECT CONDITIONS

A. Temporary Electrical Power:

a. Owner will arrange for temporary 220 VAC, single-phase, 60 Hz., GFCI-protected electricity to be available for installation of elevator components.

b. Comply with Section 015100 – Temporary Utilities.

B. Installation of the Elevator:

a. General Contractor will provide permanent three-phase power prior to installation start.

b. General Contractor will provide clear, rollable access to a 20' x 10' secure and dry storage area prior to delivery.

c. General Contractor will provide a clean, dry, and complete hoistway along with temporary installation platform and all required OSHA-compliant barricades prior to delivery.

C. Temporary Use of Elevator:

a. Owner will negotiate with manufacturer/installer for temporary use of elevator, if required.

b. Temporary use of elevator shall be in accordance with terms and conditions of manufacturer/installer's temporary acceptance form.

1.9 SCHEDULING

A. Coordinate elevator work with work of other trades, for proper time and sequence to avoid construction delays.

1.10 WARRANTY

A. Manufacturer/installer shall guarantee materials and workmanship of equipment installed under these specifications and make good, defects not due to ordinary wear or to improper use, which may develop within 1 year after completion of installation or acceptance thereof by beneficial use, whichever is earlier.

1.11 MAINTENANCE SERVICE

A. Elevator maintenance service shall be performed by elevator manufacturer/installer.

B. Elevators shall receive regular maintenance on each unit for a period of 12 months after completion of work specified herein or acceptance thereof by beneficial use, whichever is earlier.

C. Trained employees shall make periodic examinations and perform work including necessary adjusting, greasing, oiling, and replacing parts to keep elevators in operation, except parts that require replacement because of accidents, vandalism, misuse, or negligence by parties other than manufacturer/installer.

D. Manufacturer/installer shall perform all Work, except emergency minor adjustment call-back service, during regular working hours. Manufacturer/installer shall provide emergency minor adjustment call-back service, during regular working hours.

E. Should Owner request that examinations, cleaning, lubrication, adjustments, repairs, replacements, or emergency minor adjustment call-back service, unless specified herein, be performed on other than manufacturer/installer's regular working hours of regular working days, manufacturer/installer shall absorb straight-time labor charges and Owner will compensate manufacturer/installer for overtime premium, travel time, and expense at normal billing rates.

F. Elevator Control System:

a. Include built-in remote diagnostic module to relay constant status of elevators and control system to a 24-hour, 7-days-a-week central-monitoring facility.

b. Remote Monitoring Device: Transmit information on current status of elevators, including malfunctions, system errors, and shutdown.

- G. Maintenance Options
 - Regular Maintenance: During Regular Working Hours
 - Callback Service: During Regular Working Hours
 - Maintenance Period: 12

PART 2 – PRODUCTS

2.1 MANUFACTURER/INSTALLER

- B. Elevator shall be installed by elevator manufacturer.

2.2 ELEVATOR SYSTEM AND COMPONENTS

A. Electric Traction Passenger Elevators: Basis of design Otis Gen 3 gearless traction elevator. 4 stop elevator.

- B. Elevator Equipment Summary:

Application: Machine Room Less (MRL)

- a. Counterweight Location: Side
- b. Machine Location: Top of the hoistway mounted on car and counterweight guide rails
- c. Control Space Location: Top landing entrance frame or entrance frame at one floor below the top landing
- d. Service: General Purpose Passenger
- e. Quantity: 1 Unit
- f. Capacity: 3000 lbs
- g. Speed: 100 fpm
- h. Travel: 12' 0"
- i. Landings: 2
- j. Front Openings: 2
- k. Rear Openings: 0
- l. Rear Door Hand: N/A
- m. Operation: Microprocessor Single Car Automatic Operation
- o. Clear Inside Dimensions: 6' 9-5/16" Wide X 4' 10- 7/8" Deep
- p. Cab Height: 7' 9"
- q. Guide Rails: Equivalent to 12 lb. per foot
- r. Entrance Type and Width: Two Speed Side Opening 3' 6" Wide X 7' 0" High doors
- s. Entrance Height: 7'-0"

t. Power Supply: 208 Volts 3 Phase 60 Hz

C. Performance:

a. Car Speed: -10% to +5% of contract speed under any loading condition or direction of travel.

b. Car Capacity: Safely lower, stop and hold up to 125% of rated load per code.

D. Ride Quality:

a. Vertical Vibration (maximum): 25 mg

b. Horizontal Vibration (maximum): 15 mg

c. Vertical Jerk (maximum): 2 ft/sec³

d. Acceleration (maximum): 1.6 ft/sec²

e. In Car Noise: 53-60 dB(A)

f. Stopping Accuracy: ±5mm

g. Starts per hour (maximum): 180

E. Elevator Operation:

a. Simplex Collective Operation: Using a microprocessor based controller, operation shall be automatic by means of the car and hall buttons. When all calls have been answered, the car shall park at the last landing served.

b. Group Automatic Operation with Demand-Based Dispatching: Provide reprogrammable group automatic system that assigns cars to hall calls based on a dispatching algorithm designed to minimize passenger waiting time.

F. Operating Features - Standard:

a. Door Light Curtain Protection

b. Static AC Drive

c. Phase Monitor Relay

d. Cab Overload with Indicator

e. Load-weighing

f. Central Alarm

g. Remote Monitoring

h. Firefighter's Operation

i. Automatic Evacuation

l. When the main line power is lost for longer than 5 seconds the emergency battery power supply provides power automatically to the elevator controller. If the car is at a floor when the power fails, it remains at that floor, opens its doors, and shuts down. If the car is between floors, it is raised or lowered to the first available landing, opens its doors, and shuts down.

j. Independent Service

G. Operating Features - Optional:

2.3 EQUIPMENT: CONTROL COMPONENTS AND CONTROL SPACE

A. Controller: Provide microprocessor based control system to perform all of the functions of safe elevator operation, as well as perform car and group operational control.

a. All high voltage (110v or above) contact points inside the inspection and test panel shall be protected from accidental contact in a situation where the access panels are open.

b. The controller shall be distributed throughout the elevator system located in the overhead, cab and inspection and test panel. The inverter will be mounted in the overhead adjacent to the hoist machine and an inspection and test panel will be located in the door jamb at the top floor or one floor below the top floor. No elevator equipment mechanical rooms or closets are required.

c. Provide multi-bus control architecture to reduce cabling, material and waste.

B. Drive: Provide a Variable Voltage Variable Frequency AC Closed Loop drive system. Provide stable start without high peak current, quickly reaching a low energy consumption level.

C. Inspection and Test Panel: Integrated control equipment, main inspection and test panel in door frame at top level served or at one floor below the top level served.

2.4 EQUIPMENT: HOISTWAY COMPONENTS

A. Machine:

a. Gearless asynchronous AC motor with integral drive sheave, service and emergency brakes.

b. Design machine to enable direct power transfer, thereby avoiding loss of power.

c. Design machine to be compact, lightweight and durable to optimize material usage and save space.

d. Mount to structural support channels on top of guide rail system as applicable in hoistway overhead.

B. Governor:

a. Tension type over-speed governor with remote manual reset.

b. Mount to structural support channels as applicable in hoistway overhead.

C. Buffers, Car and Counterweight: Compression spring type buffers to meet code.

D. Hoistway Operating Devices:

a. Emergency Stop switch in the pit.

b. Terminal stopping switches.

c. Emergency stop switch on the machine.

E. Positioning System: System consisting of proximity sensors and door zone vanes.

F. Guide Rails and Attachments: Provide Tee-section steel rails with brackets and fasteners. Side counterweight arrangements shall have a dual purpose bracket that combines both counterweight guide rails, and one of the car guide rails to building fastening.

G. Suspension System: Non circular Elastomeric coated suspension media with high tensile grade steel cords.

H. Governor rope: Steel wire rope with 6 mm diameter.

2.5 EQUIPMENT: HOISTWAY ENTRANCES

A. Hoistway Doors and Frames:

- a. UL rated with required fire rating.
- b. Doors: Rigid flush panel construction with reinforcement ribs.
- c. Frames: Securely fasten at corners to form unit frame. Frames shall be bolted.

B. Finish:

- b. Exposed Areas of Corridor Frames: Stainless Steel - All Floors
- e. Doors: Stainless Steel - All Floors
- h. Sills: Aluminum - All Floors

C. Entrance Markings and Jamb Plates: Provide standard entrance jamb tactile markings on both jambs, at all floors. Plate Mounting: Refer to manufacturer drawings.

2.6 EQUIPMENT: CAR COMPONENTS

A. Car Frame and Safety: Provide car frame with adequate bracing to support the platform and car enclosure. The safety shall be integral to the car frame and shall be flexible guide clamp type.

B. Platform: Provide platform of steel construction with plywood subfloor and aluminum threshold.

C Car Guides: Provide sliding guide shoes mounted to top and bottom of both car and counterweight frame. Arrange each guide shoe assembly to maintain constant contact on the rail surfaces. Provide retainers in areas with Seismic design requirements.

D. Provide central guiding system to reduce mechanical friction and energy consumption.

E. Steel Cab:

a. Fire rating: Provide Class B fire rating for cab, or Class A fire rating where required by local Code.

b. Design cab to comply with LEED Indoor Environmental Quality requirements through use of Low-Emitting Materials on walls, ceiling and subflooring.

c. Car wall finish: Steel Plastic Laminate Finish selected from manufacturer's standard selections.

d. Base and frieze: Aluminum.

e. Car front finish: Brushed stainless steel.

f. Car door finish: Brushed stainless steel.

g. Ceiling: Canopy ceiling, finished in #4 Stainless Steel With Down Lit Led Lighting. Provide lighting consisting of four compact fluorescent energy saving lights located in two semi-oval lateral cutouts located on the center-sides of the cab ceiling, Lexan lens cover.

Handrail: Rectangular Brushed Aluminum - Straight End. Locate on Rear & Side Walls.

h. Flooring: By others. Not to exceed 3/8" finished depth.

i. Ventilation: Provide one-speed fan in canopy.

j. Emergency Car Lighting: Provide an emergency power unit employing a 12 volt sealed rechargeable battery and static circuits to illuminate the elevator car and provide current to the alarm bell in the event of building power failure.

k. Emergency Siren: Provide siren mounted on top of the car that is activated when the Alarm button in the car operating panel is engaged.

l. Emergency Exit Switch: Provide an electrical contact to open the safety circuit when the emergency car top exit is opened. When the exit door is opened, the top exit switch shall signal the control and the car will be unable to move.

m. Emergency Exit Lock: Provide an emergency exit lock where required by local code.

n. Emergency Exit Guard: Provide emergency exit guard on top of car when required for hoistway wall to platform clearance exceeds 12" or for multiple cars in hoistway.

2.7 DOOR OPERATOR AND REOPENING DEVICES

A. Door Operator: Provide a closed loop VVVF high performance door operator with frequency controlled drive for fast and reliable operation to open and close the car and hoistway doors simultaneously.

B. In case of interruption or failure of electric power, the doors can be readily opened by hand from within the car, in accordance with applicable code. Provide emergency devices and keys for opening doors from the landing as required by local code.

C. Doors shall open automatically when the car has arrived at or is leveling at the respective landings. Doors shall close after a predetermined time interval or immediately upon pressing of a car button. Provide door open button in the car operating panel. Momentary pressing of this button shall reopen the doors and reset the time interval.

D. Provide door hangers and tracks for each car and hoistway door. Contour tracks to match the hanger sheaves. Design hangers for power operation with provisions for vertical and lateral adjustment. Hanger sheaves shall have polyurethane tires and pre-lubricated sealed for life bearings.

E. Electronic Door Safety Device: Equip car doors with concealed transmitter and receiver infrared beam devices to detect presence of object in process of passing through hoistway entrance and car doorway (light curtain device).

a. Use multi-beam scanning without moving parts to detect obstructions in door opening.

b. Detector Device: Prevent doors from closing, or if they have already started closing, cause doors to reopen and remain open while object is within detection zone.

c. Horizontal Beams: Minimum of 33 infra red beams to fill doorway from ground level to a height of 6 feet.

2.8 EQUIPMENT: SIGNAL DEVICES AND FIXTURES

A. Car Operating Panel: Provide a car operating panel with all push buttons, key switches and message indicators for elevator operation.

a. Full height car operating panel shall be surface-mounted on front return.

b. Comply with handicap requirements.

c. Push Buttons: Mechanical, illuminating using long-lasting LEDs for each floor served.

d. Emergency Buttons: Provide in accordance with code. Emergency alarm button, door open and door close buttons.

B. Features of the Car Operating Panel Shall Include:

a. Audible chime to signal that the car is either stopping at or passing a floor served by the elevator.

b. Raised markings and Braille provided to the left hand side of each push button.

c. Car Lantern: Provide LED illuminated car lantern with direction arrows to comply with local code when hall lanterns are not provided.

d. Door open and close push buttons.

e. Firefighter's hat and Phase 2 Key-switch

f. Inspection key-switch.

g. Key-switch for optional Independent Service Operation

h. Illuminated alarm button with raised marking.

i. Elevator Data Plate marked with elevator capacity and car number.

j. Help Button: Activation of help button will initiate two-way communication between car and a location inside the building, switching over to alternate location if call is unanswered, where personnel are available to take the appropriate action. Visual indicators are provided for call initiation and call acknowledgement.

C. Hall Fixtures: Provide hall fixtures with necessary push buttons and key switches for elevator operation.

a. Push buttons: Metallic tactile push buttons, up button and down button at intermediate floors, single button at each terminal floor.

b. Height: Comply with handicap requirements.

c. Illumination: Illuminating using long-lasting low power LEDs.

D. Hall Lanterns and Position Indicators.

a. LED illuminated direction arrows with audible and visible call acknowledgement.

E. Hoistway access switches: Provide key-switch at top and/or bottom floor in entrance jamb as required by local code.

F. Firefighter's Phase 1 Service: Key switch in brushed stainless steel cover plate.

G. Fixture Cover Plates: For push buttons, hall lanterns and position indicators, resistant white back-printed glass, no screws required for mounting. Provide stainless steel cover plates for Firefighter's Phase I switch and hoistway access switches, with tamper resistant screws in same finish.

H. Mounting: Mount hall fixtures in entrance frames.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine hoistways, hoistway openings, and pits before starting elevator installation.

B. Verify hoistway, pit, overhead, and openings are of correct size, within tolerances, and are ready for work of this section.

C. Verify walls are plumb where openings occur and ready for entrance sill installation. Traditional sill angle or concrete sill support shall not be required.

D. Verify hoistway is clear and plumb, with variations not to exceed -0 to +1 inch at any point. Verify projections greater than 4" must be beveled not less than 75 degrees from horizontal. No negative tolerance is permitted for minimum hoistway dimensions.

E. Verify minimum 2-hour fire-resistance rating of hatch walls.

F. Notify Architect in writing of dimensional discrepancies or other conditions detrimental to proper installation or performance of elevators.

G. Do not proceed with elevator installation until unsatisfactory conditions have been corrected in a manner acceptable to manufacturer/installer.

3.2 INSTALLATION

A. Install elevators in accordance with manufacturer/installer's instructions and ANSI/ASME A17.1.

B. Set entrances in vertical alignment with car openings, and aligned with plumb hoistway lines.

3.3 FIELD QUALITY CONTROL

A. Perform tests of elevator as required by ANSI/ASME A17.1 and governing codes.

3.4 ADJUSTING

A. Adjust elevators for proper operation in accordance with manufacturer/installer's instructions.

B. Adjust elevators for smooth acceleration and deceleration of car so not to cause passenger discomfort.

C. Adjust doors to prevent opening of doors at landing on corridor side, unless car is at rest at that landing, or is in leveling zone and stopping at that landing.

D. Adjust automatic floor leveling feature at each floor to within 1/4 inch of landing.

E. Repair minor damages to finish in accordance with manufacturer/installer's instructions and as approved by Architect.

F. Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.5 CLEANING

A. Clean elevators promptly after installation in accordance with manufacturer/installer's instructions.

B. Do not use harsh cleaning materials or methods that could damage finish.

3.6 PROTECTION

A. Protect installed elevators from damage during construction in accordance with the negotiated temporary use agreement between Owner and manufacturer's installer.

END OF SECTION

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

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 the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Mechanical sleeve seals.
 - 3. Sleeves.
 - 4. Escutcheons.
 - 5. Grout.
 - 6. Fire-suppression equipment and piping demolition.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Painting and finishing.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber

1.4 CODES AND STANDARDS

A. All work tests and products shall conform to the latest editions of the following codes and in accordance to the following authorities:

1. NFPA 1, 13, 14, 20, 24, 25, 70, 72, 101, 230, 2001 and any other related sections.

Note: Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. Applicable material and installation standards referenced in Appendix "A" of NFPA 13 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, the more stringent requirement shall apply. All requirements found in these specifications that exceed the minimum NFPA requirements shall be incorporated into the design.

2. State Building Code
3. State Fire Safety Code
4. U.L., F.M., A.S.T.M., and A.N.S.I.
5. Authorities Having Jurisdiction (Fire Marshal's office and/or Local Fire Prevention Inspection Bureau.
6. Insurance Underwriter's Office

1.5 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

- A. Before submitting prices, thoroughly examine the contract documents with special emphasis on all the adjoining work upon which the system installation depends.
- B. No claim for extra compensation will be recognized for difficulties encountered which, in the opinion of the Architect, would have been revealed by the proper examination of the contract documents.

1.6 DESIGN INTENT

- A. General: Work shall be in accordance with the arrangement, details, and locations as indicated on the contract drawings, and supplemental addenda, or drawings issued by the Architect. Layouts are diagrammatic, and final arrangement of equipment shall suit conditions. The drawings are not intended to be sealed, but shall be followed with sufficient accuracy to coordinate completely with other trades. Work installed in a manner contrary to that shown on the drawings, or interfering with the work of another trade, shall be removed and reinstalled without any additional expense to the Owner when so directed by the Architect.
- B. Bidding Responsibility: The contract drawings and specifications are meant to provide a complete system; any piping, sprinkler heads and appurtenances found to be necessary shall be noted as such by the Contractor to the Architect prior to submission of bid. This shall include the contractor contacting the Insurance Agency during the bid process and receiving design criteria from them, especially Factory Mutual Insurance Company. Fire protection contractors bid shall be based on the Insurance Company design criteria. All equipment shall be Factory Mutual approved without exception.

- C. Coordination of Trades: This Contractor shall refer to the sprinkler drawings, architectural drawings, structural drawings, electrical and site drawings and details and all other drawings in the contract set for a full comprehension of the extent and detail of work to be performed. These drawings are intended to be supplementary to the specification, but any work indicated, mentioned or implied in either is to be considered as specified by both. It is not intended that the drawings show every pipe, fitting and appliance, but this Contractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best practice of the trades and to the satisfaction of the Architect.
- D. Performance Criteria: The engineer has developed general performance criteria for the sprinkler systems. The contractor shall be responsible for hiring a qualified engineer, registered to practice in this state, or a registered Fire Protection Engineer, as per the local authority, to prepare and be responsible for the final design of the sprinkler systems. The final design of the sprinkler systems, and any calculations, shall be submitted to the engineer for review and comment. The Engineers review of the contractors engineers design shall not, in any manner, relieve the contractor of full responsibility for the final design of the sprinkler systems.

Design Criteria:

1. Light Hazard
Light Hazard design criteria shall be as follows:
Density: 0.10 gpm per square foot over 1,500 sq. ft.
Maximum spacing per sprinkler: 225 sq. ft. (non-combustible/non-obstructed)
Hose stream: 100 gpm.
2. Ordinary Hazard
Ordinary Hazard Group 1 design criteria shall be as follows:
Density: 0.15 gpm per square foot over 1,500 sq. ft.
Maximum spacing per sprinkler: 130 sq. ft. (non-combustible/non-obstructed)
Hose stream: 250 gpm
3. Ordinary Hazard Group 2 design criteria shall be as follows:
Density: 0.18 gpm per square foot over 2,000 sq. ft.
Maximum spacing per sprinkler: 130 sq. ft. (non-combustible/non-obstructed)
Hose stream: 250 gpm

1.7 SPRINKLER STAGING

- A. Provide staging, riggings and lifts for all work under this section.

1.8 SUBMITTALS

- A. Product Data: For the following:
1. Mechanical sleeve seals.
 2. Escutcheons.
- B. Welding certificates.

1.9 QUALITY ASSURANCE

- A. The entire fire protection system shall be furnished, fabricated, installed and tested by an approved Fire Protection Contractor. Sprinklers and equipment shall be as manufactured by one of the following, or only as further specified in these documents.
 - 1. Tyco Fire Suppression & Building Products
 - 2. Victaulic Company
 - 3. The Viking Corporation
 - 4. Reliable Sprinkler Co.
- B. Sprinkler contractor shall be a certified installer and shall have been in the sprinkler business for more than five (5) years.
- C. Architectural Considerations: The contractor shall obtain approval of the architect for all mounting and support details and locations. This contractor shall pay the costs to repair any damage done by his installing crews.
- D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- E. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- F. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.10 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 plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. 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 thickness or specific material is 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.
 2. AWWA C110, rubber, flat face, **1/8 inch** thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - e. Approved equal.
 2. Sealing Elements: **[EPDM] [NBR] <Insert other>** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Plastic, **Carbon steel or Stainless steel**. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Carbon **steel with corrosion-resistant coating or Stainless steel** of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.
- 2.7 GROUT
- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 FIRE-SUPPRESSION DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

- B. 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.
- 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 to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
 - l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Existing Piping: Use the following:

- a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
 - h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
 - i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
 - j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
 - k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- 1. 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 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.4 PAINTING

- A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.5 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 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 the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.8 GROUTING

- A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 210500

SECTION 21 10 00 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

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 the following fire-suppression piping inside the building:
 - 1. Automatic Wet-pipe sprinkler systems.
- B. Related Sections include the following:
 - 1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
 - 2. Division 22 Section "Facility Water Distribution Piping" for piping outside the building.
 - 3. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride plastic.
- B. CR: Chlorosulfonated polyethylene synthetic rubber.
- C. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.
- D. PE: Polyethylene plastic.
- E. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
 - 2. Pipe hangers and supports, including seismic restraints.
 - 3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
 - 4. Air compressors, including electrical data.
 - 5. Excess-pressure pumps, including electrical data.
 - 6. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.

7. Hose connections, including size, type, and finish.
 8. Hose stations, including size, type, and finish of hose connections; type and length of fire hoses; finish of fire hose couplings; type, material, and finish of nozzles; and finish of rack.
 9. Roof hose cabinets.
 10. Monitors.
 11. Fire hydrants.
 12. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
 13. Alarm devices, including electrical data.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Fire-hydrant flow test report.
- D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13, NFPA 14 and NFPA 25. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Welding certificates.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.
- 1.6 QUALITY ASSURANCE
- A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13, "Installation of Sprinkler Systems."
 2. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
 3. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
 4. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
 5. NFPA 25 "Standard For The Inspection, Testing And Maintenance Of Water – Based Fire Protection Systems".
 6. NFPA 230, "Fire Protection of Storage."

1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 RECORD DRAWINGS

- A. The contractor shall keep daily updated accurate records of all deviations in work as actually installed from work indicated on the contract drawings. Each Contractor shall record clearly, neatly, accurately, and promptly as work progresses the following data:
 - 1. Changes made resulting from change orders or instructions or sketches issued by the A/E.
 - 2. Changes in routing made to avoid conflict with other trades or structural conditions.
 - 3. Final location of equipment and panels if different than contract documents.
- B. The record drawings shall be kept at the job site, available to the owner at all times and labeled as "Project Record Information – Job Set". When work is completed, one complete set of marked-up original prints, updated CADD drawings with all changes listed above and a CD with CADD files shall be delivered to the A/E for approval.
- C. All CADD files requested by the Contractor will be given to the contractor at a cost of \$200.00 per drawing/sheet.

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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, 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 on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile-iron gland, rubber gasket, and steel bolts and nuts.

- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.
1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
- C. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Tyco Fire Suppression & Building Products
 - 2) Victaulic Co. of America.
 - 3) The Viking Corporation
 - b. Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.
 - c. Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, prelubricated rubber gasket with center leg, and steel bolts and nuts.
 - d. Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with end matching ductile-iron-pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
 - e. Grooved-End Transition Flange: UL 213, gasketed fitting with key for ductile-iron-pipe dimensions. Include flange-type, ductile-iron housing with rubber gasket listed for use with housing and steel bolts and nuts.

2.3 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
 5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
- B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products

- 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
- C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- D. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, square-cut-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- E. Threaded-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795 or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe; hot-dip galvanized where indicated and with factory- or field-threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
 5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
- F. Plain-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795; or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe hot-dip galvanized where indicated.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation

- 5) Ward Manufacturing.
 - 6) (Approved Equal)
- G. Plain-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795, or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe hot-dip galvanized where indicated.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- H. Grooved-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795, or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe hot-dip galvanized where indicated; with factory- or field-formed, roll-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- I. Threaded-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe.
 5. Steel Threaded Couplings: ASTM A 865.
- J. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)

- K. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- L. Grooved-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed, roll-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- M. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½" and greater; and NFPA 13-specified wall thickness in NPS 6 to NPS 10.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
- N. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½" and greater; and NFPA 13 specified wall thickness in NPS 6 to NPS 10.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- O. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½" and greater; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.
1. Grooved-Joint Piping Systems:

- a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
- b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
- c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves rubber gasket listed for use with housing, and steel bolts and nuts.

2.4 CPVC PIPE AND FITTINGS

- A. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig rated pressure at 150 deg F, with plain ends. Include "Listed" and "CPVC Sprinkler Pipe" markings.
 1. CPVC Fittings: UL-listed, for 175-psig rated pressure at 150 deg F, socket type. Include "Listed" and "CPVC Sprinkler Fitting" markings.
 - a. NPS 3/4 to NPS 1-1/2: ASTM F 438 and UL 1821, Schedule 40.
 - b. NPS 2 to NPS 3: ASTM F 439 and UL 1821, Schedule 80.
 2. Adhesive: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by manufacturer of pipe and fittings.
 3. CPVC fire sprinkler system components shall only be permitted for use in:
 - a. Light Hazard Occupancies as defined by NFPA 13 2002 Edition.
 - b. Ordinary hazard rooms of otherwise light hazard occupancies where the room does not exceed 400 sq. ft., per section 6.3.6.2 of NFPA 13, 2002 Edition.
 - c. Air handling (plenum) spaces as defined by NFPA 90A.
 - d. Exposed conditions and unfinished basements in accordance with the manufacturer's Design and Installation Manual.
 - e. Combustible Concealed Spaces in accordance with the manufacturer's design and Installation Manual and applicable Specific Application Sprinkler datasheets.
 4. Manufacturers
 - a. Tyco Fire Suppression & Building Products
 - b. Victaulic
 - c. The Viking Corporation
 - d. (Approved Equal)

2.5 DIELECTRIC FITTINGS

- A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

- B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.
1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Hart Industries International, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Industries, Inc.; Wilkins Div.
 - e. (Approved Equal)
- C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.
1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. (Approved Equal)
- D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.
1. Manufacturers:
 - a. Advance Products and Systems, Inc.
 - b. Calpico, Inc.
 - c. Pipeline Seal and Insulator, Inc.
 - d. (Approved Equal)
- E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.
1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
 - c. (Approved Equal)
- F. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 225 deg F.
1. Manufacturers:
 - a. Perfection Corporation.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Co. of America.
 - d. (Approved Equal)

2.6 FLEXIBLE CONNECTORS

- A. Flexible connectors shall have materials suitable for system fluid. Include 250-psig minimum working-pressure rating and ends according to the following:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.
3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.

B. Manufacturers:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Tyco Fire Suppression & Building Products.
4. Victaulic
5. The Viking Corporation.
6. (Approved Equal)

C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.7 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.8 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

B. Outlet Specialty Fittings:

1. Manufacturers:

- a. Anvil International, Inc.
- b. Tyco Fire Suppression & Building Products
- c. Victaulic Co. of America.
- d. The Viking Corporation
- e. Ward Manufacturing.
- f. (Approved Equal)

2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.

3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:

- a. Tyco Fire Suppression & Building Products
 - b. Viking Corp.
 - c. Victaulic Co. of America.
 - d. (Approved Equal)
- D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
- 1. Manufacturers:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Potter-Roemer; Fire-Protection Div.
 - c. (Approved Equal)
- E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
- 1. Manufacturers:
 - a. AGF Manufacturing Co.
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Co. of America.
 - d. The Viking Corporation
 - e. (Approved Equal)
- F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
- 1. Manufacturers:
 - a. Tyco Fire Suppression & Building Products
 - b. Victaulic Co. of America
 - c. (Approved Equal)
- G. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.9 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
- B. Gate Valves with Wall Indicator Posts:
- 1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
 - 2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
 - 3. Manufacturers:
 - a. NIBCO.
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Co. or America
 - d. The Viking Corporation
 - e. (Approved Equal)
- C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 3. NPS 3: Ductile-iron body with grooved ends.
 4. Manufacturers:
 - a. NIBCO.
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Co. of America.
 - d. The Viking Corp.
 - e. (Approved Equal)
- D. Butterfly Valves: UL 1091.
1. NPS 2 and Smaller: Bronze body with threaded ends.
 - a. Manufacturers:
 - 1) NIBCO.
 - 2) Tyco Fire Suppression & Building Products.
 - 3) Victaulic Co. of America
 - 4) The Viking Corporation
 - 5) (Approved Equal)
 2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
 - a. Manufacturers:
 - 1) NIBCO.
 - 2) Tyco Fire Suppression & Building Products.
 - 3) Victaulic Co. of America
 - 4) The Viking Corporation
 - 5) (Approved Equal)
- E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
 - a. NIBCO.
 - b. Tyco Fire Suppression & Building Products.
 - c. Victaulic Co. of America.
 - d. The Viking Corp.
 - e. (Approved Equal)
- F. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.
 - a. Manufacturers:
 - 1) NIBCO.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America
 - 4) The Viking Corporation
 - 5) (Approved Equal)

2. **NPS 2-1/2** and Larger: Cast-iron body with flanged ends.
 - a. Manufacturers:
 - 1) NIBCO.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America
 - 4) The Viking Corporation
 - 5) (Approved Equal)

2.10 UNLISTED GENERAL-DUTY VALVES

- A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
- B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
- C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
- D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.11 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum pressure rating if sprinklers are components of high-pressure piping system.
- B. Manufacturers:
 1. Reliable Automatic Sprinkler Co., Inc.
 2. Tyco Fire Suppression & Building Products
 3. Victaulic Co. of America.
 4. Viking Corp.
 5. (Approved Equal)
- C. Automatic Sprinklers: Quick (fast) Response With heat-responsive glass bulb element complying with the following:
 1. UL 199, for nonresidential applications.
 2. UL 1626, for residential applications.
 3. UL 1767, for early-suppression, fast-response applications.
- D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
 1. Open Sprinklers: UL 199, without heat-responsive element.
 - a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
 - b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.
- E. Sprinkler types, features, and options as follows:
 1. Concealed ceiling sprinklers, including cover plate.
 2. Extended-coverage sprinklers.

3. Flow-control sprinklers, with automatic open and shutoff feature.
 4. Flush ceiling sprinklers, including escutcheon.
 5. High-pressure sprinklers.
 6. Institution sprinklers, made with a small, breakaway projection.
 7. Open sprinklers.
 8. Pendent sprinklers.
 9. Pendent, dry-type sprinklers.
 10. Quick-response sprinklers.
 11. Recessed sprinklers, including escutcheon.
 12. Sidewall sprinklers, Vertical and Horizontal Type Sprinklers.
 13. Sidewall, dry-type sprinklers.
 14. Upright sprinklers.
 15. Window – wash Vertical Pendent Sprinklers.
- F. Sprinkler Finishes: Chrome plated, bronze, and painted. (Coordinate colors with Architect).
- G. Special Coatings: Wax, lead, and corrosion-resistant paint.
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat Plastic, white finish, one piece, flat].
 2. Sidewall Mounting Plastic, white finish, one piece, flat.
- I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.
- 2.12 ALARM DEVICES
- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.
1. Manufacturers:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Co. of America
 - d. Viking Corp.
 - e. (Approved Equal)
- C. Electrically Operated Alarm: UL 464, with 6-inch- minimum diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. (Approved Equal)
- D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include 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.

1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. Tyco Fire Suppression & Building Products
 - d. Viking Corp.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. (Approved Equal)

- E. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. Tyco Fire Suppression & Building Products
 - d. Viking Corp.
 - e. (Approved Equal)

- F. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. Tyco Fire Suppression & Building Products
 - d. (Approved Equal)

- G. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. Tyco Fire Suppression & Building Products
 - d. (Approved Equal)

2.13 PRESSURE GAGES

- A. Manufacturers:

1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.
5. (Approved Equal)

- B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING APPLICATIONS, GENERAL

- A. Shop weld pipe joints where welded piping is indicated.
- B. Do not use welded joints for galvanized-steel pipe.
- C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded end joints.
- E. Underground Service-Entrance Piping: Ductile-iron, mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.
- F. Underground Service-Entrance Piping: Ductile-iron, grooved-end pipe and fittings; grooved-end-pipe couplings; and grooved joints. Include corrosion-protective encasement.
- G. Underground Service-Entrance Piping: Type K, soft copper tube; wrought-copper fittings; and brazed joints. Include corrosion-protective encasement.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
 - 1. Sprinkler-Piping Fitting Option: Specialty sprinkler fittings, NPS 2 and smaller, including mechanical-T and -cross fittings, may be used downstream from sprinkler zone valves.
 - 2. Copper-Tube Fitting Option: Copper, mechanically formed tee branches NPS 2 and smaller, with brazed joints, may be used downstream from sprinkler zone valves.

- Comply with schedule tube and branch sizes listed in UL's "Fire Protection Equipment Directory."
3. NPS 1-1/2 and Smaller: Threaded-end, black, Schedule 40 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 4. NPS 1-1/2 and Smaller: Plain-end, black, Schedule 40 steel pipe; locking-lug fittings; and twist-locked joints.
 5. NPS 1-1/2 and Smaller: Plain-end, black, Schedule 40 steel pipe; steel welding fittings; and welded joints.
 6. NPS 1-1/2 and Smaller: Plain-end, Type L, hard copper tube; wrought-copper fittings; and brazed joints.
 7. NPS 1-1/2 and Smaller: SDR 13.5, CPVC pipe; Schedule 40, CPVC fittings; and solvent-cemented joints.
 8. NPS 2: Threaded-end, black, Schedule 40 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 9. NPS 2: Plain-end, black, Schedule 40 steel pipe; locking-lug fittings; and twist-locked joints.
 10. NPS 2: Plain-end, black, Schedule 40 steel pipe; steel welding fittings; and welded joints.
 11. NPS 2: Grooved-end, black, Schedule 40 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 12. NPS 2: Plain-end, Type L, hard copper tube; wrought-copper fittings; and brazed joints.
 13. NPS 2: SDR 13.5, CPVC pipe; Schedule 80, CPVC fittings; and solvent-cemented joints.
 14. NPS 2-1/2 to NPS 3-1/2: Plain-end, black, Schedule 10 steel pipe; steel welding fittings; and welded joints.
 15. NPS 2-1/2 to NPS 3-1/2: Grooved-end, black, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 16. NPS 2-1/2 to NPS 3-1/2: Threaded-end, threadable, thinwall steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 17. NPS 2-1/2 to NPS 3-1/2: Plain-end, threadable, thinwall steel pipe; steel welding fittings; and welded joints.
 18. NPS 2-1/2 to NPS 3-1/2: Grooved-end, threadable, thinwall steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 19. NPS 2-1/2 and NPS 3: Plain-end, Type K, hard copper tube; wrought-copper fittings; and brazed joints.
 20. NPS 2-1/2 and NPS 3: SDR 13.5, CPVC pipe; Schedule 80, CPVC fittings; and solvent-cemented joints.
 21. NPS 4 to NPS 6: Plain-end, black, Schedule 10 steel pipe; steel welding fittings; and welded joints.
 22. NPS 4 to NPS 6: Grooved-end, black, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 23. NPS 4 to NPS 6: Threaded-end, threadable, thinwall steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 24. NPS 4 to NPS 6: Plain-end, threadable, thinwall steel pipe; steel welding fittings; and welded joints.
 25. NPS 4 to NPS 6: Grooved-end, threadable, thinwall steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.6 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 14.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves.
 - b. Throttling Duty: Use ball or globe valves.

3.7 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Twist-Locked Joints: Insert plain-end piping into locking-lug fitting and rotate retainer lug one-quarter turn.
- D. Pressure-Sealed Joints: Use UL-listed tool and procedure. Include use of specific equipment, pressure-sealing tool, and accessories.
- E. Mechanically Formed, Copper-Tube-Outlet Joints: Use UL-listed tool and procedure. Drill pilot hole in copper tube, form branch for collar, dimple tube to form seating stop, and braze branch tube into formed-collar outlet.
- F. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
 1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
 2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
 3. Copper Tube: Roll-groove tubing. Use grooved-end fittings and grooved-end-tube couplings.
 4. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.
- G. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
 1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
 2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
 3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.8 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
- B. 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.

- C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints. Encase piping in corrosion-protective encasement.
- D. Install underground copper service-entrance piping according to NFPA 24. Encase piping in corrosion-protective encasement.
- E. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- F. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- G. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- H. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- I. Install sprinkler piping with drains for complete system drainage.
- J. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- K. Install drain valves on standpipes.
- L. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- M. Install alarm devices in piping systems.
- N. Hangers and Supports: Comply with NFPA 13 for hanger materials.
 - 1. Install standpipe system piping according to NFPA 14.
 - 2. Install sprinkler system piping according to NFPA 13.
- O. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- P. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- Q. Drain dry-type standpipe piping.
- R. Drain dry-pipe sprinkler piping.
- S. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices.
- T. Fill wet-standpipe system piping with water.
- U. Fill wet-pipe sprinkler system piping with water.
- V. Install flexible connectors on fire-pump and pressure-maintenance-pump supply and discharge connections and in fire-suppression piping where indicated.

3.9 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 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. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.
- D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
- E. Specialty Valves:
 - 1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.
 - 2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - a. Air-Pressure Maintenance Devices for Dry-Pipe Systems: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
 - b. Install air compressor and compressed-air supply piping.
 - c. Install compressed-air supply piping from building's compressed-air piping system.
 - 3. Deluge Valves: Install in vertical position, in proper direction of flow, in main supply to deluge system.

3.10 SPRINKLER APPLICATIONS

- A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers, as indicated.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated. Listed for dry use.
 - 5. Deluge-Sprinkler Systems: Upright and pendent, open sprinklers.
 - 6. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
 - 7. Sprinkler Finishes:
 - a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated 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.
 - b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - c. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - d. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 - e. Residential Sprinklers: Dull chrome.

3.11 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles, both ways.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.12 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Connect excess-pressure pumps to the following piping and wiring:
 - 1. Sprinkler system, hydraulically.
 - 2. Pressure gages and controls, hydraulically.
 - 3. Electrical power system.
 - 4. Alarm device accessories for pump.
 - 5. Fire alarm.
- G. Connect compressed-air supply to dry-pipe sprinkler piping.
- H. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire alarm devices, including low-pressure alarm.
- I. Electrical Connections: Power wiring is specified in Division 26.
- J. Connect alarm devices to fire alarm.
- K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- M. 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 and UL 486B.

3.13 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 .

3.14 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 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.
 - 3. Energize circuits to electrical equipment and devices.
 - 4. Start and run excess-pressure pumps.
 - 5. Start and run air compressors.
 - 6. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 7. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
 - 8. Coordinate with fire alarm tests. Operate as required.
 - 9. Coordinate with fire-pump tests. Operate as required.
 - 10. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.15 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

3.16 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Alignment guides and anchors.
2. Sleeves without waterstop.
3. Grout.
4. Silicone sealants.
5. Escutcheons.

1.2 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.
 - a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
 - b. Include operating characteristics and furnished accessories.

- B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

C. Silicone Sealants:

2.2 ESCUTCHEONS

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. BrassCraft Manufacturing Co.; a Masco company
2. Jones Stephens Corp.
3. Mid-America Fittings, LLC; A Midland Industries Company

B. Basis-of-Design Product: Subject to compliance with requirements, provide BrassCraft or comparable product by one of the following:

1. BrassCraft Manufacturing Co.; a Masco company
2. Jones Stephens Corp.
3. Mid-America Fittings, LLC; A Midland Industries Company

C. Escutcheon Types:

1. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed, and, exposed-rivet hinge; and spring-clip fasteners.

- D. Floor Plates:
 - 1. Split Floor Plates: Cast brass with concealed hinge.

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 expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- B. Install rubber packless expansion joints in accordance with 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 one 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 SLEEVES - GENERAL

- 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 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.
- 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 joint sealants that joint sealant manufacturer's literature indicates is 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."

3.6 INSTALLATION OF ESCUTCHEONS

- 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.

3.7 FIELD QUALITY CONTROL

- A. Sleeves and Sleeve Seals:
 - 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
 - 2. Prepare test and inspection reports.
- B. Escutcheons:
 - 1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.8 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 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. Sleeves with waterstops.
 4. Interior Wall and Partitions:
 - a. Sleeves without waterstops.

3.9 ESCUTCHEONS APPLICATION

- A. Escutcheons for New Piping and Relocated Existing Piping:
1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 2. Chrome-Plated Piping: One piece, steel with polished, chrome-plated finish.
 3. Insulated Piping:
 - a. One piece, steel with **[polished, chrome-plated][polished brass]** finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated finish.
 - d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated finish.
 - d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 5. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated finish.
 - d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with polished, chrome-plated finish.
 - c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with **[polished, chrome-plated][rough-brass]** finish.
 - c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

- B. Escutcheons for Existing Piping to Remain:
 1. Chrome-Plated Piping: Split casting, stamped steel with concealed hinge with polished, chrome-plated finish.
 2. Insulated Piping: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish
 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 6. Bare Piping in Equipment Rooms: Split plate, stamped steel with concealed hinge 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.
 2. Existing Piping: Split floor plate.

END OF SECTION

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes Cx process requirements for the following plumbing systems, assemblies, and equipment:
 - 1. Sanitary waste and vent piping.
 - 2. Storm drainage piping.
 - 3. Plumbing equipment.
- 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. IAPMO: International Association of Plumbing and Mechanical Officials.
- D. IgCC: International Green Construction Code.
- E. "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:
 - 1. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to plumbing to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements", IAPMO "Green Plumbing and Mechanical Code Supplement," and ASHRAE 202.
- C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, 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 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 Cx PROCESS

- A. Perform Cx process for plumbing systems in accordance with:
1. 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 plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in ASHRAE 202. Contractor performs the following:
1. Review plumbing preliminary construction checklists and provide written comments on Construction 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)." 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 plumbing 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)." 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. 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. Meters and gauges.
 - g. General-duty and specialty valves.
 - h. Hangers and supports.

- i. Heat tracing.
 - j. Vibration isolation and seismic restraints.
2. 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. Tubs, drain connections, and faucets.
 - f. Showers, supplies, drain connections, and faucets.
 - g. Wash fountains, supplies, drain connections, and faucets.
 - h. Emergency plumbing fixtures, supplies, drain connections, and controls.
 - i. Drinking fountains, supplies, and drainage connections.

3.3 Cx TESTING PREPARATION

- A. Certify that plumbing 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 plumbing system 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 that all systems are set to and maintaining set points as required by the design documents.
- C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with 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 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 compared 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 test 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. Cx Construction Checklist verification tests.
 - 2. Cx Construction Checklist verification test demonstrations.

END OF SECTION 220800

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.2 ACTION SUBMITTALS

A. Product Data:

1. PVC pipe and fittings.

B. Sustainable Design Submittals:

C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 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.

1.4 FIELD 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 in accordance with requirements indicated:

1. Notify Architect 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 Architect's written permission.

1.5 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
 1. Soil, Waste, and Vent Piping: 10 ft. head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation 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 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 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. 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.

2.3 PVC PIPE AND 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. Apollo Valves; a part of Aalberts Integrated Piping Systems
 2. Charlotte Pipe and Foundry Company
 3. North America Pipe Corporation
- B. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.
- C. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
- D. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.
- E. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- F. Adhesive Primer: ASTM F656.
 1. Adhesive primer shall have a VOC content of 550 g/L or less.
 2. Adhesive primer 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."

3. Adhesive primer 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Adhesive primer 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

G. Solvent Cement: ASTM D2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. 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 220548.13 "Vibration 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.
1. 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.
 2. 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.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 3. Do not change direction of flow more than 90 degrees.
 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste 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 and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: Two 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 Sanitary Waste Piping: Two percent downward in direction of flow.
 3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- O. Install steel piping in accordance with applicable plumbing code.
- P. Install stainless steel piping in accordance with ASME A112.3.1 and applicable plumbing code.
- Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."
- R. Install aboveground ABS piping in accordance with ASTM D2661.
- S. Install aboveground PVC piping in accordance with ASTM D2665.
- T. Install underground PVC piping in accordance with ASTM D2321.
- U. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- V. Install underground, ductile-iron, force-main piping according to AWWA C600.
1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- W. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."
1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- X. Install force mains at elevations indicated.
- Y. Plumbing Specialties:
1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- AA. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
- BB. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."
- CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for escutcheons specified in Section 220500 "Common Work

Results for Plumbing."

3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.
 - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- E. Join stainless steel pipe and fittings with gaskets in accordance with ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. 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.
- I. 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. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
 - 3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.
- J. Joint Restraints and Sway Bracing:
 - 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater

than two pipe sizes.

- b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
- c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 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. 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. Install individual, straight, horizontal piping runs:
 - a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52 spring hangers.
- C. Install hangers for PVC 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 of each fitting, valve, and coupling.
- E. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste

- Piping Specialties."
6. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main.
 2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections in accordance with 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.
- 3.6 IDENTIFICATION
- A. Identify exposed sanitary waste and vent piping.
 - B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
- 3.7 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.
 - 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.
 - 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.
- E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 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. Exposed Plastic Piping: Protect PVC plumbing vents exposed to sunlight with two coats of water-based latex paint.

- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 (DN 100) is to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Air-admittance valves.
4. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
2. Section 221323 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.

1.2 DEFINITIONS

A. 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. Plastic Floor Cleanouts (Insert drawing designation, if any):

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. IPS Corporation
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Zurn Industries, LLC
2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

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. Sleeve Flashing Device :

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

C. Expansion Joints :

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

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 sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- F. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- G. Install wood-blocking reinforcement for wall-mounting-type specialties.
- H. 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

SECTION 221329 - SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible effluent pumps.
2. Sewage-pump basins and basin covers.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for applications in storm-drainage systems.
2. Section 333200 "Site Packaged Sewage Pumping Stations" for applications in site-construction sewage pumping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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. 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.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 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 manufacturer's written instructions for handling.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.2 SUBMERSIBLE EFFLUENT PUMPS

- A. Submersible, Fixed-Position, Single-Seal Effluent Pumps:
 - 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. GRUNDFOS CBS Inc.
 - b. Liberty Pumps
 - 2. Description: Factory-assembled and -tested effluent-pump unit.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
 - 4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 - 5. Impeller: Statically and dynamically balanced, ASTM A48/A48M, Class No. 25 A cast iron, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
 - 6. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
 - 7. Seal: Mechanical.
 - 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Oil.
 - 9. Controls, Rod-and-Float Type:
 - a. Enclosure: NEMA 250, Type 1.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
 - 10. Controls, Float- and Pressure-Switch Type:
 - a. Enclosure: NEMA 250, Type 1; **[pedestal][wall]** mounted.
 - b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120 V ac,

with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

- a. Remote Alarm Contacts: For remote alarm interface.
- b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.

B. Capacities and Characteristics:

- 1. Unit Capacity: 50 gpm.
- 2. Number of Pumps: One.
- 3. Each Pump:
 - a. Capacity: 50 gpm.
 - b. Solids Handling Capability: Not applicable.
 - c. Total Dynamic Head: 35feet.
 - d. Speed: 3450.
 - e. Discharge Pipe Size: 1-1/2" NPS.
 - f. Motor Horsepower: 1/2 hp.
 - g. Electrical Characteristics:
 - 1) Volts: 120 V ac.
 - 2) Phases: Single.
 - 3) Hertz: 60.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.3 INSTALLATION

A. Pump Installation Standards:

- 1. Comply with HI 1.4 for installation of centrifugal pumps.
- 2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

B. Equipment Mounting:

- 1. Install progressing-cavity sewage pumps 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 vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

- C. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 1. Perform each 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.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 221329

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and General Provisions of Contract, including General and Modifications to General Conditions and Division 1 Specification Sections, apply to work specified in this Section.
- B. Equality of materials, articles, assembly or systems, other than those named or described in this Section, will be determined in accordance with the provisions given to Substitutions.
- C. All work in this Section is subject to the codes and standards of this Section unless otherwise listed in Section 230548 "Vibration and Seismic Controls", which will take precedence.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Inserts.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Concrete bases.
 - 9. Supports and anchorages.
 - 10. Flashing of curbs.
 - 11. Openings in walls.
 - 12. Cutting and patching
 - 13. Painting.
 - 14. Electrical wiring.
 - 15. Vibration Isolation and seismic controls.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and within chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. "Contractor" means specifically sub-contractor working under his respective Section of the Specifications.
- G. "Furnish" and "Provide" mean to supply, erect, install and connect up complete in readiness for regular operation, particular work referred to, unless otherwise specified.
- H. "Piping" includes, in addition to pipe, all fittings, valves, hangers and other accessories relating to such piping.
- I. "Ductwork" includes, in addition to ducts, all fittings, hangers, dampers, elbows, transitions, access panels, breaker strips, flexible connections and other accessories relating to ductwork.
- J. "Supply" means purchase and delivery of material to the site.
- K. "Install" means to erect in place the supplied item.

1.4 SUBMITTALS

- A. Submit color samples for pipe coding system.
- B. Submit copies for approval and record of:
 - 1. All Tests.
 - 2. Balancing Report.
 - 3. Valve Chart.
 - 4. Pipe Color Code Chart.
 - 5. Maintenance Manuals.
 - 6. All products and materials supplied under Division 23.
- C. Any additional cost or loss, or damage arising from the substitution of any material or method for those originally specified shall be borne by the Contractor, notwithstanding review or acceptance of such substitution by the Owner or the Architect, unless the substitution was made at the written request of the Owner. Any cost for re-design of any components of the contract documents shall be borne by the Contractor, unless the substitution was made at the written request of the Owner.
- D. Submittals shall be used by the contractor to coordinate location and size of access requirements, and location of piping, duct, drain, and electrical connections. Where the submittal is lacking proper information, the contractor shall obtain certified drawings or manufacturers installation brochures and instructions for the equipment before proceeding with the work.

1.5 SUBSTITUTIONS

- A. Requests for substitutions shall be submitted in writing two (2) weeks prior to bid opening. Otherwise, substitutions will only be considered when a product becomes unavailable through no fault of the Contractor.

- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- C. A request constitutes a representation that the Contractor:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality and operating efficiency level of the specified product.
 - 2. Has investigated proposed product and determined that it meets or exceeds the performance and has lower sound power ratings than the specified product.
 - 3. Has investigated proposed product and determined that it physically fits in the space designed, and does not require extensive revision of structural framing.
 - 4. Will provide the same warranty for the Substitution as for the specified product.
 - 5. Will coordinate installation and make changes to other Work which may be required for the Work to be complete in all respects with no additional cost to Owner.
 - 6. Waives claims for additional costs or time extension which may subsequently become apparent.
 - 7. Will reimburse Owner for review or re-design services associated with re-approval by authorities.
- D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require revision to the Contract Documents.
- E. Engineer will determine acceptability of proposed substitution and will notify Contractor of acceptance or rejection in writing within a reasonable time.
- F. The Mechanical Contractor shall be responsible for the cost of and coordination of electrical revisions required as a result of the use of substituted equipment including modification to wire size, breaker size, wire routing, or starter/disconnect accessory differences.
- G. Only one request for substitution will be considered for each product. When substitution is not accepted, provide the specified product. If a substitution is submitted and rejected more than one time, the Engineer reserves the right to bill the Mechanical Contractor for additional review hours at the hourly rate established in the AIA Contract.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified with no additional cost to the owner. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- D. Piping shall be fabricated by a qualified licensed plumber/pipefitter and/or steamfitters.
- E. Drainage piping shall be installed by a qualified drain layer.

1.7 SCOPE OF WORK

- A. Provide all labor, materials, equipment, controls and accessories necessary to complete the work shown on the Drawings or herein specified to provide complete and operable systems.
- B. The work to be done under this Division includes all related work shown on the Drawings and or included in these Specifications.
- C. Provide commissioning of all mechanical systems; the general contractor as well as all sub-contractors shall cooperate with the commissioning agent and provide all required information to aid in system commissioning. Commissioning does not replace any specified start-up and testing of major pieces of equipment owned by the Mechanical Contractor.
- D. Drawings are diagrammatic and all duct and pipe fittings, transitions, or offsets required for installation in the actual space are not necessarily shown. Changes in duct size, shape, and route must be coordinated and approved prior to fabrication or installation.

1.8 MATERIALS

- A. Any device, material or construction required to complete the job that is not specifically covered by description herein shall be of commercial-grade material normally used for the purpose and installed in a manner consistent with the conditions of use. Items exposed to the elements shall be weatherproofed or protected. All such items shall be submitted for review before being purchased or installed.

1.9 CODES AND STANDARDS

- A. Materials and equipment shall be designed, constructed, installed and tested in accordance with this Specification and the latest editions of the following applicable standards in addition to state and local codes applying. All products shall bear the label of approval from the appropriate agency.

Agencies:

National Environmental System Contractors Assoc.	NESCA
Air Moving and Conditioning Association	AMCA
American Society of Heating, Refrigerating and Air Conditioning Engineers	ASHRAE
American Society of Mechanical Engineers	ASME
Federal Construction Safety Standards (U.S. Dept. of Labor)	FCSS
American Society of Testing Materials	ASTM
National Electric Code	NEC
National Electrical Manufacturers Association	NEMA
National Fire Code	NFC
Occupational Safety and Health Act of '70	OSHA
International Building Code (Latest Edition)	IBC
National Sanitation Foundation	NSF
Air Conditioning and Refrigeration Inst.	ARI
Underwriters Laboratories, Inc.	UL
Building Officials & Code Administrators International, Inc.	BOCA
International Code Council	ICC
National Fire Protection Association	NFPA
Sheet Metal and Air Conditioning Contractors National Association	SMACNA
American National Standards Institute	ANSI
American Welding Society	AWS
Cast Iron Soil Pipe Institute	CISPI
Clean Air Act Amendment of 1990 (Title VI. Section 608)	CAA
Cooling Tower Institute	CTI

International Mechanical Code

IMC

- B. Any materials or workmanship called for in the requirements of the above-mentioned standards which are not specified or shown on the Drawings, shall be furnished and installed by the Contractors as though same had been specifically mentioned or indicated.
- C. If these Contractors fail to notify the A/E at this time, and install work in variance with the above-mentioned codes and regulations, they shall assume responsibility and expense to rectify the installation to the satisfaction of the A/E and Owner.
- D. Secure all local, state and federal permits necessary in connection with the installation of the equipment, including licenses and approvals and pay fees required for same.
- E. All work shall be performed in strict accordance with the above-mentioned standards, local and state codes.
- F. File all necessary Plans and Documents with Local Authorities and obtain the necessary Certificates of Inspection for work. Deliver same to A/E prior to request for acceptance and final payment.
- G. Notify A/E of any deviation from codes of work indicated or herein specified before installation of work is affected.

1.10 WORK PROCEDURE

- A. The Contractor shall, in good workmanlike manner, perform all work and furnish all supplies and materials, machinery, equipment, refrigerant charges, water treatment, equipment support structures including those for VFD/Starter, hoisting, rigging, and means, herein and otherwise specified, necessary or proper to perform and complete all work required by the Plans and Specifications in order to have a complete and satisfactory installation acceptable to the A/E.

1.11 DELIVERY, STORAGE, HANDLING AND PROTECTION

- A. Prior to installation, and after installation, follow Sections in Division 1.
- B. During construction, close open ends of work subject to weather or adverse conditions with temporary covers or plugs to prevent entry of water, dirt and obstructing materials.

1.12 COOPERATION WITH OTHER TRADES / COORDINATION DRAWINGS

- A. Cooperate to fullest extent with all other trades to best expedite the entire work.
- B. Furnish all information pertaining to materials, sizes, locations, means of support, etc., to all other trades requiring such information.
- C. Where work of Contractor will be installed in close proximity to work of other trades, or where there is evidence that work of Contractor will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustment.
- D. Contractor shall prepare composite working "COORDINATION" drawings and sections at suitable scale not less than $\frac{1}{4}" = 1'-0"$ clearly showing how his work is to be installed in relation to work of other trades. The contractor shall identify any conflicts, investigate and suggest possible resolutions, and request assistance from the Architect / Engineer for assistance in resolving a field

condition in order to complete the work required. No additional compensation will be granted or awarded for resolving coordination issues since this is considered part of this contractor's duties. Coordination drawings for suggested resolution of coordination issues shall be produced by this contractor and submitted for review by the Engineer.

1.12 GUARANTEE

- A. The system specified herein and shown on the drawings shall be guaranteed to be free from original defects in both material and workmanship and shall perform to manufacturer specification for a period of **two (2) years** of normal use and service, excepting damages from other causes. Systems which are manufactured ISO-9001 certification are preferred. This guarantee shall become effective starting the date the Contract work is accepted as complete by the Architect on behalf of the Owner and in accordance with the General Provisions/Conditions.
- B. Upon completion of the installation, this contractor shall submit to the owner a proposal for a standard maintenance agreement to support the system operation for one year beyond the warranty period. This service should include an option for manufacturer's recommended service maintenance for equipment as well as 24-hour emergency response
- C. Upon completion of the installation, the ATC Subcontractor shall submit to the Owner an agreement to provide the necessary programmed maintenance, to keep the various control systems in proper working condition **for one year** beyond the guarantee period. Additionally, this contractor shall submit to the owner its standard agreement to support the system operation. This service must include operators support, application support, remote diagnostic support as well as database management support. This service shall be available 365 days/year, 24 hours a day.
- D. This programmed maintenance agreement shall fully describe the maintenance work to be performed and shall advise as to the cost of this work prior to awarding of Contract.

1.14 RECORD DRAWINGS

- A. The contractor shall keep daily updated accurate records of all deviations in work as actually installed from work indicated on the contract drawings. Each Contractor shall record clearly, neatly, accurately, and promptly as work progresses the following data:
 - 1. Changes made resulting from change orders or instructions or sketches issued by the A/E.
 - 2. Changes in routing made to avoid conflict with other trades or structural conditions.
 - 3. Final location of equipment and panels if different than contract documents.
- B. The record drawings shall be kept at the job site, available to the Owner at all times and labeled as "Project Record Information – Job Set". When work is completed, one complete set of marked-up original prints, updated Cad drawings with all changes listed above and a CD with Cad files shall be delivered to the A/E for approval.

PART 2- PRODUCTS

2.1 GENERAL

- A. All products shall be new and without defects.

- B. Products required by construction but not specifically described herein shall be as selected by the Contractor subject to the approval of the A/E.
- C. All products of Section 230548 Vibration and Seismic Controls shall take preference over the products of this Section.
- D. All products shall be of an approved type and shall be designed for the pressures and temperatures at which they are to be operated, for the materials they are to handle and for their intended use.

2.2 DUCTWORK

- A. Refer to individual Division 23 Ductwork Sections for duct materials, accessories, and installation methods.
- B. Where ductwork penetrates any smoke and/or fire rated partitions provide UL listed dynamic fire and/or smoke dampers per NFPA Guidelines. Install dampers per manufacturer's instructions and install a duct and architectural access panels for every damper as required to test, inspect, and reset.
- C. Provide duct access doors for all motorized dampers, air flow stations, fire & smoke dampers, duct smoke detectors, the entering side of every coil, and at all other locations where components are installed within ductwork regardless of whether or not an access is indicated on the floor plans.
- D. All changes in duct direction shall be made in solid ductwork, not flexible duct.
- E. Square-throat/round-heel elbows are not allowed.
- F. Seal and pressure test ductwork as required in Section 233113 Metal Ducts.

2.3 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.4 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- D. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.5 SLEEVES

- A. Through outside masonry walls and below grade masonry walls, use schedule 40 ductile iron, caulked watertight.
- B. Through masonry floors or interior masonry walls and fire rated assemblies, use Schedule 40 galvanized steel pipe.
- C. Through interior non-fire rated stud partitions, use 22-gauge galvanized sheet metal.
- D. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- E. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- F. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- H. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- I. PVC Pipe: ASTM D 1785, Schedule 40.
- J. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. Escutcheons for pipes passing through outside walls shall be solid cast brass, flat type, secured to pipe with a set screw, Ritter Pattern & Casting Co., #1.
- B. Escutcheons for pipes passing through floors shall be split hinged, cast brass type designed to fit pipe on one end and cover sleeve projection through floor on other end, Ritter Pattern & Casting Company, #36A.
- C. Escutcheons for pipes passing through interior walls, partitions and ceilings shall be split-hinged, cast brass, chromium plated type, Ritter Pattern & Casting Co., #3A.
- D. Beaton & Corbin and/or Caldwell products will be acceptable.

2.7 INSERTS

- A. Inserts shall be individual or strip type, of pressed steel construction galvanized only with accommodation for removable nuts and threaded rods up to $\frac{3}{4}$ " diameter, permitting lateral adjustment. Individual inserts shall have an opening at top to allow reinforcing rods up to $\frac{1}{2}$ " diameter to be passed through insert body and shall be Fee & Mason Manufacturing Company, Figure 178. Strip inserts shall have attached rods with hooked ends to allow fastening to reinforcing rods and shall be Fee & Mason Manufacturing Company, Figure 190. Grinnell or Carpenter Patterson materials will be acceptable.

- B. At Contractor's option, inserts may be galvanized, malleable iron, Universal type, Grinnell, Figure 279, for pipe sized up to 3½", Figure 282, for all sizes up to 8".
- C. Where subject to corrosive atmospheres use stainless steel products.

2.8 ACCESS DOORS

- A. The contractor shall furnish access panels not smaller than 12 x 16" for access to concealed valves, traps, dampers, sensors, etc. where no other means of access is provided. Access panels shall be all steel construction with no. 16 gauge wall or ceiling and no. 14 gauge panel door with not less than 1/8" insulation secured to inside of the door. Doors shall be supported with concealed hinges and secured with suitable clips and countersunk flush screws. Outside of access panels shall be flush with finished wall or ceilings, except that where panels are located in acoustic tile or paneling, the door shall be recessed to receive adjacent finish material. The final position for each access door and the size to be used shall be determined by the contractor. Access panels shall be as manufactured by MILCOR. Fire ratings of access door shall not be less than the surface on which the door is installed.

PART 3- EXECUTION

3.1 GENERAL

- A. All installation methods of Section 230548 "Vibration and Seismic Controls" shall take precedence over the methods of this Section.

3.2 INTERPRETATION OF DRAWINGS

- A. Mechanical equipment and such other apparatus as may require maintenance and operation from time to time shall be made easily accessible. Although the equipment may be shown on the Drawings in certain locations, the construction may disclose that such locations do not make its position readily accessible. In such cases, the Owner or his Representative shall be notified before advancing the construction to a stage where a change will reflect additional expense.
- B. Compare actual site conditions with the Drawings and Specifications and include additional work which careful examination would disclose. Before the bidding period, advise the A/E of any omission, error or conflict in the Plans and Specifications.
- C. Equipment, ductwork and piping locations, as shown, are diagrammatic and approximate only unless fixed by dimensions. As the drawings are diagrammatic, every fitting, transition, and offset required for the installation is not shown on the drawings, but shall be anticipated to be necessary for the installation by the contractor. Actual field conditions and physical characteristics of the product govern exact locations. Where possible, adhere to locations on Drawing consistent with building construction and equipment installed by others.
- D. Contractor shall not scale measurements from the Drawings but check with General Contractor's latest Drawings, shop drawings, and equipment manufacturer's installation guides before proceeding with any work.
- E. Work layouts shall be the responsibility of the Contractor, following minimum requirements as set forth in these Specifications and accompanying Drawings.
- F. Where head room or space conditions appear inadequate, A/E shall be notified before proceeding with installation. If directed by A/E, Contractor shall, without extra charge, make reasonable

modifications in layout as needed to prevent conflicts with work of other trades or for proper execution of work.

- G. If, in Contractor's opinion, work is shown or specified in manner or amount as to make it impossible to install a top quality piece of work or fulfilling intent of a perfectly efficient job when complete, refer same to A/E in writing before submitting proposals. The contractor shall suggest options for solutions to conflicts for review by the engineer.
- H. Should Contractor fail to refer such instances to A/E as required above, no excuse for poor, defective or incomplete work will be accepted.

3.3 SHOP DRAWINGS

- A. All equipment shall be submitted for approval under these Sections to the A/E.
- B. Do not place orders for any equipment until final approval is received. Allow at least two weeks for submittal review.
- C. If material or equipment is installed before it is approved, Contractor shall be liable for removal and replacement at no extra charge to the Owner.
- D. Contractor shall consult manufacturer's installation brochures and instructions to determine exact location of connection points. Take special care to allow for proper space for maintenance, operation of valves, removal of coils, filters and equipment. Provide offset pipe and union/flange arrangements for ease of removal of coils and equipment. Provide accessories required or recommended by the manufacturer. Locate drains for proper pitch and trapping for coils, space for control valves, and other components. Coordinate with electrical contractor by advising of proper location of attachment of electrical devices to be clear of areas of maintenance or access.
- E. Shop drawings shall be submitted on all major pieces of equipment and material. Each item of equipment proposed shall be a standard catalog product of an established manufacturer. The shop drawing shall give complete information on the proposed equipment such as: capacity, size, construction, material, dimensions, arrangement, operating clearances, performance characteristics, weight and rating authority. Each item of the shop drawing shall be properly labeled, indicating the intended service of the material.
- F. The contractor shall, before submitting the shop drawings of the equipment to the A/E, check each item of the shop drawings to verify the proper equipment is included. Items to check shall include but not be limited to confirmation that the equipment will physically fit into space; proper equipment for the job; electrical characteristics including operating efficiencies and voltage matches that of electric service; proper arrangements for connections; that the equipment meets code requirements, and that all required BMS/DDC components are included.
- G. The shop drawings shall be submitted electronically to the A/E with a letter of transmittal, which shall list each item, submitted with the manufacturer's name.
- H. Review of the shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings have been reviewed, said review does not mean that drawings have been checked in detail; said review does not in any way relieve the contractor from his responsibility or the necessity of furnishing material or performing work as required by the contract drawings.

3.4 WARRANTY

- A. Refer to General Conditions. The warranty period for the work under this Section is for TWO years from date of acceptance. These contractors shall provide free day-and-night service, parts and labor for the complete installation of the entire system for this period.

3.5 CONTRACTOR'S RESPONSIBILITY

- A. Contractor shall be held responsible for any injuries to people, employees or damage done to building premises or adjoining areas or to other work resulting from execution on his part of work, in any manner whatsoever.
- B. Contractor shall be responsible for proper protection of his work, materials, people or employees from injury or loss done by others and shall make good such injury at his own expense.
- C. The Engineer shall not be responsible for the safety of Contractor's employees.
- D. The contractor shall be responsible for coordination with the electrical contractor with regard to final diffuser & smoke detector installation. Smoke detectors should not be located in a direct air-flow or closer than 1 m (3 ft) from an air supply diffuser or return air opening. Supply or return sources larger than those commonly found in residential and small commercial establishments can require greater clearance to smoke detectors. Similarly, smoke detectors should be located farther away from high velocity air supplies.

3.6 CUTTING AND PATCHING

- A. All rough cutting and patching required for installation of the mechanical system shall be the responsibility of this contractor. All finish patching relative to this contractor's work shall be the responsibility of other trades in accordance with other sections of this specification. Coordinate all work for a complete and finished installation.
- B. Contractor shall furnish sketches showing the locations and sizes of all openings and chases, and furnish and locate all sleeves and inserts required for the installation of the mechanical work before the walls, floors and roof are built. The contractor shall be responsible for the cost of cutting and patching where any mechanical items were not installed or where incorrectly sized or located. The contractor shall do all drilling required for the installation of his hangers.

3.7 TESTING

- A. Refer to sections 230800 "Commissioning of HVAC", 019113 "General Commissioning Requirements", and 230593 "Testing, Adjusting and Balancing for HVAC" for the requirements of coordination, verification, and reporting of tests.
- B. Contractor shall submit to the A/E for record and approval a written report for each test conducted including manufacturer's equipment start-up testing. Report shall indicate date of test, system tested, method of testing, name of person or agency witnessing test, and results of tests. If test records are not kept and submitted, it will be assumed that the test was not completed and Contractor will be required to perform the test at A/E 's direction.
- C. All piping, ducts and equipment shall be tested. Contractor shall furnish Labor, materials, instruments and power required for testing unless otherwise indicated under particular section of Specifications.

- D. Tests shall be scheduled in advance, and shall be performed in presence of and to satisfaction of A/E, Commissioning Agent, Owner's Representative and/or such other parties as may have jurisdiction.
- E. Pressure test shall be applied to piping and ductwork only before connection of equipment. In no case shall piping, equipment or accessories be subjected to pressures exceeding their ratings.
- F. Provisions for capping and sealing ductwork and piping in preparation of testing, and restoring for final connection to equipment is the responsibility of this contractor.
- G. Ductwork shall be tested in accordance with SMACNA HVAC Duct Leakage Test Manual, with a minimum test of 25% of all ducts operating in excess of 3" wc total static pressure on fans, all ducts installed outdoors, all ducts that will be concealed within shafts, solid ceiling, crawl spaces, or solid soffits in the finished condition. In no case shall the maximum leakage allowed be equal to or greater than the SMACNA permitted leakage rates. Ductwork shall be resealed, sealant allowed to cure, and retested until all mains and all sections outdoors and within concealed ceilings, soffits, shafts and chases meets the leakage requirements.
- H. Defective work shall be promptly repaired or replaced and tests shall be repeated until particular system and/or component parts receive approval of the A/E.
- I. Any damages resulting from tests shall be repaired and damaged materials replaced.
- J. Duration and style of tests shall be as determined by authorities having jurisdiction or Commissioning Agent directive, but in no case less than time prescribed in each Section of Specifications. In general, pressure for tests shall be 1.5 times working pressure unless prescribed otherwise by code, specific specification section or ASTM Guidelines.
- K. Equipment and systems which normally operate during certain seasons of year shall be tested during appropriate season. Test shall be performed on individual equipment, systems and their controls for proper operation, functioning and performance. Controls shall be operated simultaneously with equipment of system being tested.
- L. During testing procedure, remove accessories liable to damage during tests.
- M. Notice shall be furnished to A/E at least two days prior to any testing. Contractor shall be solely responsible for any delays, damages, etc., resulting from failure to notify.
- N. Instruments required under this Contract for permanent installation may be used for testing if re-adjusted and recalibrated for the service for which intended.

3.8 CLEANING OF SYSTEM

- A. All piping, ducts and equipment shall be thoroughly cleaned of foreign matter after being placed in operation. System shall be disconnected, cleaned and reconnected wherever necessary to locate and remove obstructions. Any work damaged in course of removing obstructions shall be repaired or replaced when system is reconnected at no additional cost to the Owner.
- B. Replace all air filters with new prior to balancing of air systems.

3.9 SLEEVES, INSERTS, ANCHOR BOLTS

- A. Sleeves shall be located by this Contractor and set by the General Contractor, subject to A/E approval. Provide General Contractor with such information in ample time to prevent unnecessary cutting and patching. Mechanical Contractor shall be responsible for and subsequent cutting and patching of openings if sleeves have been omitted due to failure of setting them properly or in time. Fasten sleeves securely to avoid dislocation during concrete pouring.
- B. In placing sleeves, inserts, anchor bolts or any other material to be embedded in masonry and concrete or built into structure, Contractor shall cooperate with all other trades and shall consult with A/E in regard to their exact locations wherever there is any interference with structural members.
- C. Contractor will be held responsible for location of and maintaining in proper positions, sleeves, inserts and anchor bolts supplied and/or set in place by him. In event that failure to do so requires cutting and patching of finished work, it shall be done at Contractor's expense.
- D. All pipes and conduits passing through floors, walls or partitions shall be provided with sleeves having an internal diameter two inches larger than outside diameter of pipe.
- E. Sleeves through outside walls shall be painted with one coat of bitumastic paint inside and outside. Sleeves shall extend ½" beyond each side of wall. Space between sleeve and pipe shall be packed with oakum to within two inches of each face of wall. Remaining space shall be packed and made watertight with a waterproof compound.
- F. Sleeves through masonry floors or interior masonry walls shall be set flush with finished wall or ceiling surfaces.
- G. Sleeves through interior stud partitions shall be set flush with finished surfaces of partitions.

3.10 ESCUTCHEONS

- A. Escutcheons shall be installed on pipes wherever they pass through floors, ceilings, wall partitions and outside walls where exposed to view.

3.11 OPERATING INSTRUCTIONS

A. Operation of system - Instruction:

- 1. Contractor is responsible for construction and installation of all mechanical systems and shall supply the services of competent personnel for a period of one day per system (heating, cooling, controls) plus one day per major piece of equipment (VRF heat pumps, ERVs, air cooled condensers) to instruct owner's personal. As such, Contractor may be required during the first year to review every phase of all mechanical systems with Owner's personnel and also to instruct and supervise Owner's personnel in the proper operation and maintenance of said system. Time shall be recorded by Contractor and signed by Owner or Representative. At the owner's request, the training instruction shall be video recorded and shall be included in the Operating Manual package.

B. Operation of system - Manuals:

- 1. Contractor shall provide complete operating instructions of all systems installed, provided as electronic documents in MS Word or Adobe PDF format. Manuals shall be labeled with job name, address and date. Information on each piece of equipment of system shall be in a separate tab labeled section. Provide a complete index of the contents. After approval by the Engineer the zip files shall be forwarded to the Owner.

2. Manual shall contain one approved copy of each shop drawing and submitted data, printed instructions as to care and maintenance of system arranged in the following sequence:
 - a. Table of Contents
 - b. Description of Installation with Contractor contact information and letter of Warranty including start date and terms.
 - c. Care and Maintenance: Including a check and follow-up chart for greasing and oiling of all mechanical equipment and a copy of instructions as to upkeep of motors.
 - d. Manufacturer's Listing: In alphabetical order, of all equipment installed on job, together with a listing of material supplied, manufacturer's address, name and address of local manufacturer's agent.
 - e. Copy of Service Valve Charts
 - f. Copy of Pipe System complete with color samples.
 - g. Testing & Balancing Report
 - h. Duct Pressure Test Report
 - i. Equipment start-up report and records including incident reports and refrigerant charges
 - j. List of filter sizes for all mechanical equipment including "clean filter" pressure drop gauge reading and "change filter" pressure drop gauge reading
 - k. Updated Automatic Temperature Control submittal & sequence of operations
 - l. Operating & Maintenance manuals for the automatic temperature control system
 - m. Manufacturer's Equipment Warranties
 - n. Project documents and certificates
 - o. The manual shall also include a schedule for all equipment maintenance. Schedule shall provide a general outline for equipment requirement. Example; filters shall be changed every 3 months, test dampers once a year

3.12 PROJECT CLOSEOUT AND TROUBLE SHOOTING

- A. Each trade shall designate one person to methodically test, adjust, trouble shoot and effect repairs to all equipment, devices and systems. The person shall be available on one hour's notice to answer trouble calls and to fully investigate and repair the cause of the problem. Each trade shall submit the name and phone number of the designated person to the Owner, Engineer and Architect. After final acceptance, this same person shall be available on eight hour's notice for free day-and-night service during the guarantee period.
- B. Contractor shall demonstrate all sequences of control to the Commissioning Agent and Engineer. The temperature control and balancing sub-contractors shall accompany the Commissioning Agent and Engineer during check-out procedure and shall demonstrate proper balancing positions of minimum fresh-air settings. Personnel shall be equipped with tools and spare parts to make minor repairs and adjustments.
- C. Balanced positions shall be indicated with permanent marker on valves; label filter gauges with "clean filter pressure drop" and "change filter pressure drop".
- D. Contractor shall demonstrate compliance with balancing of systems in the presence of the Engineer by actual measurement of water and air flows at a minimum of three locations randomly selected by the Engineer. If requested by the Engineer, re-balancing shall be done at no additional charge.

3.13 FIRE STOPPING

- A. Each trade is responsible for fire stopping of its own work.
- B. Fire stopping material shall be typical of HILTI Fire Barrier.
- C. Each trade must submit intended fire stopping material and methods for each application with UL listed approved designs.

3.14 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. 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.
- 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 with provisions to permit expansion.
- G. Install piping to permit valve servicing.
- H. Install piping at indicated slopes.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install piping to allow application of insulation. Arrange operable accessories so that the final insulation thickness will not restrict the operation of valve handles or connection of hose fittings on drains.
- L. Select system components with pressure rating equal to or greater than system operating pressure.
- M. Install escutcheons for penetrations of walls, ceilings, and floors.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire/Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.15 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems and approved joining methods for this project.
- B. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. 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.
- G. 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 or flexible, where required, grooved-end-pipe couplings. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide

on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically review the product installation. Only a direct employee of the grooved system manufacturer shall be considered suitable for field service. A distributor's representative is not to be considered qualified for field service. Contractor shall remove and replace any improperly installed products.

- H. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
- I. Press type fittings shall only be allowed with written permission of the A/E or Owner.

3.16 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.17 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC 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.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 230500

SECTION 23 05 29

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. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.

1.2 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 HVAC piping and equipment shall withstand the effects of gravity loads and stresses.
 - 1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.3 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. Pipe Hangers.
 - 2. Trapeze pipe hangers.
 - 3. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. 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.

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.
- 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.

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 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, zinc-coated or stainless 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.

2.4 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 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. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation for use in lightweight concrete or concrete slabs less than 4 inches thick:
 - 1. 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.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. 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.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.

- I. 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.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. 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.
- L. 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. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - 4. 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.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

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. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and 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.

3.4 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: 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.
- C. 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 carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper 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. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 6. 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.
 7. 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.
 8. 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.
 9. 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 not necessary.
- 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.
- 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. 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.
 - 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 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. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 - 3. 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.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Hangers for horizontal lines, except as noted below and in Section 230500 -
- 1. Vibration Isolation and Seismic Restraint, shall be spaced no greater than as follows:

Pipe Size	Rod Diameter	Maximum Spacing	
		Copper	Steel
1/2"	3/8"	5' - 0"	7' - 0"
3/4"	3/8"	5' - 0"	7' - 0"
1"	3/8"	6' - 0"	7' - 0"
1 1/4"	3/8"	7' - 0"	7' - 0"
1 1/2"	3/8"	8' - 0"	9' - 0"
2"	3/8"	8' - 0"	10' - 0"
2 1/2"	1/2"	9' - 0"	11' - 0"
3"	1/2"	10' - 0"	12' - 0"
4" - 5"	5/8"	12' - 0"	14' - 0"
6" - 8"	3/4"	14' - 0"	17' - 0"

- 2. Copper tubing shall be supported with split ring hangers, copperized with supporting rod.
 - 3. Cast iron soil pipe shall be hung one hanger for each pipe length, close to hub.
 - 4. PVC pipe shall be supported no more than 4'-0" on center.
 - 5. Use insulation protection saddles or shields for all insulated cold piping and where hanger is outside the insulation. Secure all saddles and shields to the insulation to prevent slippage or shifting that may cause the shield to fall to the ground. Saddles shall be spot welded to hangers.
- R. Hangers for vertical pipes shall be spaced no greater than as follows:

PIPING MATERIAL	MAX. VERTICAL SPACING
Cast Iron Pipe	15'-0"
Copper Pipe/Tubing	10'-0"
Galvanized Steel Pipe	15'-0"
PVC Pipe	4'-0"
CPVC Pipe/Tubing	3'-0"

END OF SECTION 230529

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Intent

1. All mechanical equipment, piping and ductwork shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
3. It is the intent of the seismic portion of this Specification to keep all mechanical building system components in place during a seismic event when required by local code.
4. All such systems must be installed in strict accordance with seismic codes, component manufacturers' and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.
5. This Specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e., California Title 24; California OSHPD; Canadian Building Codes; or, other requirements).
6. The Contractor shall correct any variance or non-compliance with these Specification requirements in an approved manner.
7. Seismic restraints shall be designed in accordance with seismic force levels as detailed in the State Building Codes.
8. All in-line equipment will be braced independently of the ducts or pipes and in conformance with all applicable building codes.

B. The work in this Section includes, but is not limited to, the following:

1. Vibration isolation for piping, ductwork and equipment.
2. Seismic restraints for all new gas piping.
3. Equipment isolation bases.
5. Seismic restraints for isolated equipment.
6. Seismic restraints for non-isolated equipment.
7. Certification of seismic restraint designs and installation supervision.
8. Certification of seismic attachment of housekeeping pads.
9. All mechanical systems - equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical (equipment not listed is still included in this Specification):

IDU Units	Ductwork	Condensate Piping
Air Distrib. Boxes	Fans (All Types)	Pumps (All Types)
Air Handling Units	Heat Pumps	Rooftop ERVs
Condensing Units	Refrigerant Piping	Units Heaters

C. Definitions

1. Positive Attachment:
 - a. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double-sided beam clamp loaded perpendicular to a beam, or a welded or bolted

connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, electrical conduit, bus duct, or cable trays, or any other equipment are not acceptable on this project as seismic anchor points.

2. Transverse Bracing:
 - a. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.
3. Longitudinal Bracing:
 - a. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

1.2 SUBMITTAL DATA REQUIREMENTS

- A. The manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:

1. Descriptive Data:
 - a. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the Specification.
 - b. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive Drawings.
2. Shop Drawings:
 - a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 - b. Provide all details of suspension and support for ceiling hung equipment.
 - c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
 - d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
3. Seismic Certification and Analysis:
 - a. Calculations shall be based on "G" forces appropriate for the zone in which the building is located.
 - b. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a Registered Professional Engineer with at least five years of seismic design experience, licensed in the State of the job location.
 - c. All restraining devices shall have a pre-approval number from California's OSHPD or some other recognized government agency showing maximum restraint ratings. Pre-approvals based on independent testing are preferred to pre-approvals based on calculations. Where pre-approved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a Registered Professional Engineer with at least five years of seismic design experience and licensed in the State of the job location. Test-

ing and calculations must include shear and tensile loads as well as one test or analysis at 45° to the weakest mode.

- d. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in the State Building Code acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.3 CODE AND STANDARDS REQUIREMENTS

A. Typical Applicable Codes and Standards

1. Applicable State Building Code.
2. Applicable State Mechanical Code.
3. Applicable State Plumbing and Gas Codes.
4. SMACNA
5. NFPA

1.4 MANUFACTURERS' RESPONSIBILITIES

A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:

1. Determine vibration isolation and seismic restraint sizes and locations.
2. Provide vibration isolation and seismic restraints as scheduled or specified.
3. Provide calculations and materials if required for restraint of un-isolated equipment.
4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.5 RELATED WORK

A. Supplementary Support Steel:

1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc., including roof mounted equipment, as required or specified.

B. Attachments:

1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double-sided beam clamps, etc., in accordance with the requirements of the vibration vendor's calculations.

PART 2 - PRODUCTS

2.1 INTENT

- A. All vibration isolators and seismic restraints described in this Section shall be the product of a single manufacturer. Mason Industry's products are the basis of these Specifications; products of other manufacturers are acceptable provided their systems strictly comply with the Specifications and have the approval of the specifying engineer. Submittals and certification sheets shall be in accordance with Section 230500.
- B. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" and/or horizontal permanent deformation greater than 1/4".

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraints:

1. Two layers of ¾" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc. or equal.
2. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" and all-directional seismic capability. The mount shall consist of a ductile iron casting containing two separated-and-opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be Type BR as manufactured by Mason Industries, Inc. or equal.
3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between two steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in three planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge-bearing quality. Bushing assemblies shall be Type PB as manufactured by Mason Industries, Inc. or equal.
4. A one-piece molded bridge bearing neoprene washer/ bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal-to-metal contact. Neoprene bushings shall be Type HG as manufactured by Mason Industries, Inc. or equal.
5. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or ¼" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be Type SLF as manufactured by Mason Industries, Inc. or equal.
6. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of ½" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage pre-approval "R" number from OSHPD in the State of California certifying the maximum certified horizontal and vertical load ratings. Mountings shall be SLR as manufactured by Mason Industries, Inc. or equal.

7. Spring mountings, as in Specification 5, built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of ¼" travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be SSLFH as manufactured by Mason Industries, Inc. or equal.
8. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8". Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician. Air springs shall be Type MT and leveling valves Type LV, as manufactured by Mason Industries, Inc. or equal.
9. Restrained air spring mountings shall have an MT air spring, as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of ½" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc. or equal.
10. Hangers shall consist of rigid steel frames containing minimum 1¼" thick neoprene elements at the top and a steel spring with general characteristics, as in Specification 5, seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side-to-side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be Type 30N, as manufactured by Mason Industries, Inc. or equal.
11. Hangers shall be as described in paragraph 10 above, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be Type PC30N, as manufactured by Mason Industries, Inc. or equal.
12. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc. or equal.

- a. Cables will be wire-core with a minimum breaking strength as shown in the table below. The cable size is for reference only. The actual cable size should be chosen to provide the breaking strength indicated in the table. Use FS = 2.0 when pre-stretched cable is used with end connections that develop the breaking strength of the cables; otherwise, use FS = 5.0.

Minimum Breaking Strength for Cable Braces

Size inches	Breaking Strength FS = 2.0 pounds	Breaking Strength FS = 5.0 pounds
	¼	4,940
3/8	10,980	27,450
½	19,260	48,150

- b. Cable will be zinc-coated to a minimum of 0.4 ounces per square foot or stainless steel per ASTM A304. Tighten cable only to remove slack.
- c. Use either cable or solid bracing for all situations. Do not mix bracing types.
13. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Seismic solid, brace-end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be Type SSB, as manufactured by Mason Industries, Inc. or equal.
- a. Cold-formed angles will conform to the material and identification requirements of the latest *Specifications for the Design of Cold-Formed Steel Structural Members* of the American Iron and Steel Institute with a minimum $F_y = 33$ ksi and a minimum $F_u = 38$ ksi.
- b. The uncoated minimum steel thickness of the cold-formed product as delivered to the job site will not, at any location, be less than 95% of the thickness indicated in the table below. The thickness may be less at bends after cold-forming.

Standard Sheet Metal Gages

Gage	Standard Uncoated Thickness inches	Galvanized Thickness inches

12	0.1046	0.1084
14	0.0747	0.0785
16	0.0598	0.0635

- c. Hot-rolled shapes and plates will conform to ASTM A36. Pipes used as braces will be standard steel pipes (ASTM A120 or A53).

Note: Specifications 12 through 13 apply to trapeze as well as clevis hanger locations. At trapeze anchor locations, piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.

14. Pipe clevis cross-bolt braces are required in all restraint locations. They shall be special purpose, pre-formed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage pre-approval "R" number from OSHPD in the State of California. Clevis cross braces shall be type CCB, as manufactured by Mason Industries, Inc. or equal.
15. All-directional seismic snubbers shall consist of inter-locking steel members restrained by a one-piece-molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of ¼" thick. Rated loadings shall not exceed 1,000 psi. A minimum air gap of 1/8" shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1225, as manufactured by Mason Industries, Inc. or equal.
16. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of ¾" thick. Rated loadings shall not exceed 1,000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more than ¼". Snubbers shall be installed with factory-set clearances. The capacity of the seismic snubber at 3/8" deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to ½" deflection in the X, Y and Z planes. Snubbers shall have an anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be series Z-1011, as manufactured by Mason Industries, Inc. or equal.
17. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder, which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS, as manufactured by Mason Industries, Inc. or equal.
18. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an Evaluation Report Number from the I.C.B.O Evaluation

ation Service, Inc. verifying to its allowable loads. Drill-in female wedge anchors shall be Type SAB, as manufactured by Mason Industries, Inc. or equal.

19. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machine bases may be T or L shaped where space is a problem. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1". Bases shall be type WF, as manufactured by Mason Industries, Inc. or equal.
20. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of ¼" thick. Steel springs shall be laterally stable and rest on ¼" thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs' waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs' waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2" of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit must be solidly fastened to the top floating rail and the lower Z section anchored to the roof structure. Curb shall have anchorage pre-approval "R" from OSHPD in the State of California attesting to the maximum certified horizontal and vertical load ratings. Curb shall be type RSC, as manufactured by Mason Industries, Inc. or equal.
21. Split wall seals consist of two bolted pipe halves with minimum ¾" thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240° F, 10# density fiberglass may be used in lieu of the ponge. Seals shall be type SWS, as manufactured by Mason Industries, Inc. or equal.
22. Bolts will conform to ASTM A307. Bolt holes will be a maximum of 1/16" (1.6 mm) larger than the bolt diameter unless noted otherwise.
23. Expansion anchors will have local-governing-jurisdiction-approved values equal to, or greater than, both the shear and tension capacities listed in the table below. Cast-in-place concrete inserts may replace expansion anchors where the approved loads are equal to, or greater than, the values for the specified expansion anchors.

Minimum Approved Values for Expansion Anchors

Size	Shear Capacity	Tension Capacity
inches	pounds	pounds
3/8	675	615

1/2	1,130	1,040
5/8	1,580	1,535
3/4	2,270	2,020
7/8	5,060	3,705

324. Welding will conform to AWS D1.1 and use either the shielded or submerged arc methods. Attachments to building components may be subject to review by the design professional.

PART 3 - EXECUTION

3.1 GENERAL

- A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.
- C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- D. The Contractor shall not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Coordinate work with other trades to avoid rigid contact with the building.
- F. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the A/E's attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible Contractor's expense.
- G. Bring to the A/E's attention any discrepancies between the Specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible Contractor's expense.
- H. At no additional cost, correct all installations that are deemed defective in workmanship and materials, at the Contractor's expense.
- I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the Structural Engineer of record for approval. Generally, bracing may occur from:
 - 1. Flanges of structural beams.
 - 2. Upper truss cords in bar joist construction.
 - 3. Cast-in-place inserts or wedge-type, drill-in concrete anchors.
- J. All attachments to structural elements will be reviewed with the appropriate design professional.

- K. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- L. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.
- M. At locations where Specifications 12 or 13 restraints are located, the support rods must be braced where necessary to accept compressive loads with Specification 14 braces.
- N. At all locations where Specifications 12 or 13 restraints are attached to pipe clevis', the clevis cross bolt must be reinforced with Specification Type 15 braces.
- O. Drill-in concrete anchors for ceiling and wall installation shall be Specification Type 18 and Specification Type 19 female wedge-type for floor mounted equipment.
- P. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.
- Q. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed Specification 23 capabilities.
- R. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide Specification 27 wall seals.
- S. Air handling equipment and centrifugal fans shall be protected against excessive displacement that results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be Specification Type 28.
- T. Locate isolation hangers as near to the overhead support structure as possible.
- U. When conduit is required to be braced, it may be braced the same as the equivalent weight pipe.
- V. All runs will have a minimum of two transverse braces and one longitudinal brace.
 - 1. A run is defined as a length of duct or pipe without any change in direction except as allowed by offsets

3.2 VIBRATION ISOLATION OF PIPING

- A. Horizontal Pipe Isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in Specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps' Specification 14. Hangers as described in Specification 10 shall isolate horizontal runs in all other locations throughout the building. Floor-supported piping shall rest on isolators as described in Specification 6. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces, the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3". Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment, install expansion joints.
- B. Riser Isolation: Risers shall be suspended from Specification 10 hangers or supported by Specification 5 mountings, anchored with Specification 25 anchors and guided with Specification 26 sliding guides. Steel springs shall be a minimum of 0.75" except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load. Submittals must

include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

3.3 SEISMIC RESTRAINT OF PIPING

- A. Seismically restrain all piping listed as 1, 2 or 3 below. If isolated, use Specification 12 cables. Specifications 12 or 13 restraints may be used on un-isolated piping.
 - 1. Gas piping.
 - 2. Refrigeration in equipment rooms that is 1¼" I.D. and larger.
 - 3. All other piping, 2½" diameter and larger.
- B. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads or is otherwise noted in this Specification.
- C. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads or is otherwise noted in this Specification.
- D. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
- E. For all gas piping up to 5", transverse restraints must be at 20' maximum and longitudinal restraints at 40' maximum spacing.
- F. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or TEE, or combined stresses are within allowable limits at longer distances.
- G. Hold-down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
- H. Branch lines may not be used to restrain main lines.
- I. Provide joints capable of accommodating seismic displacements where pipes pass through building seismic or expansion joints or where rigidly supported pipes connect to equipment with vibration isolators. The joints must be allowed motion in all directions.
- J. A rigid piping system will not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
- L. Vertical risers not specifically engineered will be laterally supported with a riser clamp at each floor. For buildings greater than six stories high, all risers will be engineered individually.

3.4 VIBRATION ISOLATION OF DUCTWORK

- A. All discharge runs for a distance of 50' from the connected equipment shall be isolated from the building structure by means of Specification 10 hangers or Specification 5 floor isolators. Spring deflection shall be a minimum of 0.75".
- B. All duct runs having air velocity of 1,000 fpm or more, shall be isolated from the building structure by Specification 11 hangers or five floor supports. Spring deflection shall be a minimum of 0.75".

3.5 SEISMIC RESTRAINT OF DUCTWORK

- A. Seismically restrain all ductwork with Specification 12 or 13 restraints as listed below:
1. Restrain rectangular ducts with cross sectional area of 6 sq. ft. or larger.
 2. Restrain round ducts with diameters of 33" or larger.
 3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
- B. Transverse restraints shall occur at 30' intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
- C. Longitudinal restraints shall occur at 60' intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within four feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
- D. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
- E. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
- F. Unbraced ducts will be installed with a 6" minimum clearance to vertical ceiling hanger wires.
- G. Walls, including gypsum board non-bearing partitions, that have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame at all stud wall construction.

3.6 SEISMIC RESTRAINT OF MECHANICAL EQUIPMENT

- A. All mechanical equipment shall be vibration isolated and seismically restrained as per Section 2.02 of this Specification.

3.7 SEISMIC RESTRAINT EXCLUSIONS

- A. Piping:
1. All piping less than 2½" in diameter except those listed in Section 3.03, paragraph A.
 2. All piping in mechanical equipment rooms less than 1¼" I.D except where noted otherwise in this Specification and in Section 3.03, paragraph A.1.
 3. All clevis or trapeze supported piping suspended from hanger rods where the point of attachment is less than the 12" in length from the structure to top of pipe, except those listed in Section 3.03, paragraph A.1.
- B. Ductwork:
1. Rectangular, square or oval ducts less than six square feet in cross sectional area.
 2. Round duct less than 33" in diameter.
 3. No bracing is required if the duct is suspended by hangers 12" or less in length, as measured from the top of the duct to the bottom of the support where the hanger is attached. Hangers must be positively attached to the duct with 2" of the top of the duct with a minimum of two #10 sheet metal screws.

END OF SECTION 230548

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. General Provisions for Mechanical Work Section 230500 shall apply to all work performed under this Section of the Specifications and shall be considered as included herein.

1.2 SUMMARY

- A. Provide identification devices specified in this section.
- a. Section Includes:
 - b. Equipment labels
 - c. Warning signs and labels.
 - d. Pipe labels.
 - e. Duct labels.
 - f. Stencils.
 - g. Valve tags.
 - h. Warning tags.

1.3 RELATED SECTIONS

- A. All Sections of Division 23 apply to work in this Section.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
 - a. The following colors shall be used for piping identification unless noted otherwise:

Service	Legend	Background Color
Refrigerant Liquid Pipe	Liquid	Yellow
Refrigerant Suction Pipe	Suction	Yellow
Refrigerant Hot Gas Pipe	Hot Gas	Yellow
A/C Condensate	AC Cond	Yellow

Note: Color banding shall meet latest edition of NSI and OSHA requirements.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8 ½ "x 11" bond paper. Tabulate valve number, piping system, system abbreviation (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Section 15010.
- E. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Section 15010.

1.6 WARRANTIES

- A. Provide one year maintenance warranty for all pieces of equipment. See Division 1 for additional warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, products are limited to Seton, Brady or Brimar whom have a minimum of 5 years experience in the manufacturing of mechanical identification products.

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 15 sections. Where more than single type is specified for application, selections is Installer's option, but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS

- A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 duct work.
- B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
- C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

2.4 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1. Must be secured to pipe with adhesive flow arrow tape at both ends.
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker secured to pipe with flow arrow tape.
 - 2. Adhesive lap joint in pipe marker overlap.
 - 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1 1/2".
- F. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
 - 1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.5 VALVE TAGS

- A. Brass Valve Tags: Provide 1/16" (1.5mm) thick polished brass valve tags with stamp-engraved piping system abbreviation in 3/8" (8mm) high letters and sequenced valve numbers 3/4" (9.5mm) high, and with 1/8" (3mm) hole for fastener.
 - 1. Provide 1 1/2" (37mm) diameter tags, except as otherwise indicated.
 - 2. Provide size and shape as specified or scheduled for each piping system.
 - 3. Fill tag engraving with black enamel.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.6 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.7 EQUIPMENT LABELS

- A. All equipment labels shall be made of 3 ply 3/16" engraved phenolic with low glare finish. Labels shall be electrically non-conductive and abrasion resistant. Labels shall have mounting holes and adhesive backing.

2.8 WARNING SIGNS AND LABELS

- A. All WARNING labels shall be made of 3 ply 3/16" engraved phenolic with low glare finish. Labels shall be electrically non-conductive and abrasion resistant. Labels shall have mounting holes and shall be permanently attached. Background color shall be yellow with red lettering.

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which required insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Where air systems have been balanced, the Contractor shall permanently mark, ON THE DEVICE, the correct balancing settling of each valve, damper, or similar device.

3.2 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, exhaust, and outdoor air intake ductwork with stenciled signs and arrow, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 foot spacing along exposed runs.
- C. Access Doors: Provide plastic duct access door markers on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information. Where acoustic ceilings are below the access, provide duplicate marker on ceiling tile, ceiling grid, or ceiling access panel.

3.3 PIPING SYSTEM IDENTIFICATION

- A. General: install pipe markers on each system listed on the color chart Paragraph 1.04.B.1.a. indicate nominal pipe size (i.e. 4" HS) and include arrows to show normal direction of flow.
- B. Locate pipe markers and color bands as follows wherever piping and ductwork is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations and concealed above ceiling spaces.
 1. Near each valve and control device.
 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 4. At access doors and similar access points which permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.

6. Spaced intermediately at maximum spacing of 50 feet along each piping run, except reduce spacing to 25 feet in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings.

3.4 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve and control device in each piping system; exclude valves within factory-fabricated equipment, and HVAC terminal devices 50 mm and smaller and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
 1. Tagging Schedule: Valve tags shall be sequential.
- B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by the Owner.

3.5 EQUIPMENT LABELS

- A. Equipment labels shall include, but not limited to the following applicable information:

Schedule Tag	CFM
Equipment Served	Static Pressure
Equipment Manufacturer	Type of Service
Equipment Model	Filter Size & Quantity
Horsepower	Zone Served
Fan RPM	Voltage

- B. Provide equipment labels for:

Exhaust Fans	Heat Pumps
Room Fan Coil Units (ACs)	Condensing Units
Variable Frequency Drives	Rooftop Units/ERVs
Cabinet and Unit Heaters	Indoor ERVs
VAV Boxes	Temperature Control Panels

3.6 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.7 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 12) for each piping system, additional system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 1. Where stenciled markers are provided (ductwork only), clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION 230553

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Work in this section shall be performed by a certified TAB contractor retained by the Mechanical Contractor as part of this Project.
- B. The Mechanical contractor and ATC sub-contractor's services are required to assist in and support the TAB work. The cooperation and participation of the Mechanical Contractor and all subcontractors is required.
 - 1. The Mechanical contractor shall include any costs for required TAB activities, including those of their subcontractors, in the contract price.
 - 2. Include TAB participation requirements and activities in all subcontracts and schedules.
 - 3. Include the services of the sheet metal contractor for temporary capping of the duct mains for pressure testing, and reconnection of the branch ducts after testing is complete.
- C. Section Includes:
 - 1. Commissioning Responsibilities of the TAB contractor.
 - 2. Pressure testing of air duct systems.
 - 3. Balancing Air Systems:
 - a. Constant-volume air systems.
 - 4. Documenting temperatures and heat transfer of Heat Pump VRF equipment.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. 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.
- B. Certified TAB reports.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB 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. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 COMMISSIONING TEAM RESPONSIBILITIES

- A. Refer to Division 01 Section 019100 "General Commissioning Requirements" for commissioning team member roles and responsibilities.
- B. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved prior to final CxA Testing of equipment and systems.
- C. Prior to scheduling of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- D. The Mechanical Contractor shall notify the GC and CxA at least ten (10) days in advance of systems being ready for testing and balancing work, for dates to be scheduled with the CxA and TAB contractor and shall provide access for the CxA to witness testing and balancing Work.
- E. Provide technicians, instrumentation, and tools to support testing and balancing of HVAC&R systems at the direction of the CxA.
 1. The CxA will notify testing and balancing subcontractor ten (10) days in advance of the date of field verification in order for dates and times to be coordinated with the CxA, Mechanical contractor, and the ATC sub-contractor. Notice will not include data points to be verified.
 2. If re-testing is required, the testing and balancing subcontractor shall use the same instruments by model and serial number that were used when original data were collected.
 3. Failure of an item is defined by a deviation of more than 10 percent of any pertinent variable other than sound. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
 4. The Mechanical Contractor shall remedy the deficiency and notify the GC and CxA so verification of failed portions can be performed, and so that repeat of the TAB testing can be scheduled.

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 systems for installed balancing devices, such as test ports, thermometers flow-control devices, fittings, motorized and manual volume dampers. Verify that locations of these balancing devices are accessible and controllable by the manufacturer's controls and/or the BMS to set damper positions and verify that CFM readings tested match the CFM of the airflow station devices.
- 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. This contractor shall pressure test ductwork in the presence of the CxA, and as specified in Division 23 Section Metal Ducts. A leakage report shall be submitted to the GC and CxA to be forwarded to the A/E. Repeat testing of failed sections after confirmed repair by the Mechanical Contractor.
 - 1. The MC is responsible for and shall coordinate the requirements of the ductwork pressure test with his sheetmetal subcontractor.
 - 2. Advanced planning is required, including but not limited to installation of temporary caps on duct branches and mains in order to facilitate testing. Failure to plan for the tests does not alleviate the duct pressure test requirement.
 - 3. Failure to schedule the test to include attendance by the CxA will require the test to be repeated.
 - 4. Duct sections that do not pass the pressure test shall be resealed and retested. Additional TAB labor and any delay caused to the work of other trades is the responsibility of the Mechanical Contractor.
 - 5. After successful testing is completed, the duct branches shall be reconnected, sealed, and insulation repaired.
- F. Examine equipment performance data including fan 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 factory start-up, field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed. Identify and log all deficiencies (example: missing volume dampers, disconnected ductwork, missing insulation, obvious air leaks) and submit to the MC and CxA. The MC shall repair all noted deficiencies and sign off log.

- H. Examine test reports specified in individual system and equipment Sections.
- I. Replace all air filters with new.
- J. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation. Construction filters must be replaced with final filters prior to TAB. If additional construction work is on-going after the testing, additional protection should be in place to protect the system such as return register/intake filter material covers.
- K. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine operating safety interlocks and controls on HVAC equipment.
- N. 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 strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Refrigerant systems are clean, charged, and pressure tested. Confirm that branch circuit controls and LEV kits are operating properly.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- 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. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

- C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with marker, paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in U.S. standard 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. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Replace all air filters and identify clean and dirty pressure drops.
- D. Locate all volume dampers in system and correct schematic diagrams of systems' "as-built" duct layouts.
- E. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- F. 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.
- G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- H. Verify that motor starters are equipped with properly sized thermal protection.
- I. Check dampers for proper position to achieve desired airflow path.
- J. Check for airflow blockages.
- K. Check condensate drains for proper connections and functioning.
- L. Check for proper sealing of air-handling-unit components.
- M. Verify that air duct system is sealed as specified in Division 23 Section "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. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.

- c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop ERV unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. 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.
 6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, VFDs, and belt sizes to achieve indicated air-handling-unit performance.
 7. 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 will occur. 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 within specified tolerances.
 1. Measure airflow of ductwork branch ducts.
 - a. Where sufficient space in branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure CFM at a point downstream from the balancing damper and adjust volume dampers until the proper CFM is achieved.
 3. Remeasure each main and submain after all branch ducts have been adjusted. Continue to adjust submain and branch ducts to indicated CFM airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- E. Remeasure each main and submain after all inlet and outlets have been adjusted. Continue to adjust submain and branch ducts to indicated CFM airflows within specified tolerances.

3.6 PROCEDURES FOR CONDENSING UNITS AND HEAT PUMPS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.
- D. Record electrical data.

3.7 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Mode of operation (Heating/Cooling/Dehumidification).
 - 2. Dry-bulb temperature of entering and leaving air.
 - 3. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 4. Airflow.
 - 5. Air pressure drop.
 - 6. Refrigerant suction pressure and temperature.
- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.

3.8 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: +/- 10%.
 - 2. Air Outlets and Inlets: +/- 10%.
 - 3. Heating-Mode Supply Air Temperature: +/- 10%.
 - 4. Cooling-Mode Supply Air Temperature: +/- 10%.

3.9 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 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.

3.10 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.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. 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 contractor.
 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. Weather conditions and operating mode of system at time of testing.
 10. Signature of TAB supervisor who certifies the report.
 11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 12. 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.
 13. Nomenclature sheets for each item of equipment.
 14. Data for terminal units, including manufacturer's name, type, size, and fittings.
 15. Notes to explain why certain final data in the body of reports vary from indicated values.
 16. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, bypass-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.

- e. Inlet vane settings for variable-air-volume systems.
 - f. Settings for supply-air, static-pressure controller.
 - g. 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. Outdoor, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Terminal units.
 - 4. Balancing stations.
 - 5. Position of balancing devices.
- 3.11 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.
- 3.12 SPECIAL REQUIREMENTS
- A. If readings shown on the balancing report or from actual site visit are not acceptable to the Engineer, the Balancing Contractor shall spot test (witnessed by the Engineer) as many pieces of equipment or air outlets at no additional cost.
- 3.13 TRAINING OF OWNER PERSONNEL
- A. The TAB contractor shall have the following training responsibilities:
 - 1. TAB shall meet with facility staff after completion of TAB and instruct them on the following:
 - a. Review the final TAB report, explaining the layout and meanings of each data type.
 - b. Discuss any outstanding deficiencies in control, ductwork, piping or system design that may affect the proper delivery of air or refrigerant.
 - c. Identify and discuss any terminal units, duct runs, diffusers, coils, and fans that are close to or are not meeting their design capacity.
 - d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 - e. Other salient information that may be useful for facility operations, relative to TAB.

END OF SECTION 230593

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Polyolefin.
 - e. Polystyrene.
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied jackets.
10. Tapes.
11. Securements.
12. Corner angles.

B. Related Sections:

1. Division 22 Section "Plumbing Insulation."
2. Division 23 Section "Metal Ducts" for duct liners.

C. Scope:

1. Insulate refrigerant piping.
2. Insulate all copper AC condensate piping.
3. Insulate all supply and intake ductwork where connected to an outside air ducts.

1.2 SUBMITTALS

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

B. Shop Drawings:

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, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties, equipment connections, and access panels.
4. Detail application of field-applied jackets.
5. Detail application at duct access panels and volume dampers.
6. Detail application at linkages of control devices.

7. Detail field application for each equipment type.
- C. Field quality-control reports.
- 1.3 QUALITY ASSURANCE
- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting 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 and inspecting 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.

PART 2 - PRODUCTS

2.1 REFRIGERANT/COOLING CONDENSATE INSULATION

- A. Provide and install insulation on all piping and equipment as listed manufactured by Armacell.
1. Copper AC Condensate Piping: 1" thick insulation
 2. PVC or Vinyl AC Condensate Piping: No Insulation Required
 3. Refrigerant Piping, Indoors, for Split Systems: 1" thick insulation with paintable jacket
 4. Refrigeration Piping, Outdoors, for Split Systems: 2" thick insulation with Pittwrap Jacket
- B. Insulation material shall be a flexible, closed-cell elastomeric insulation in tubular form model AP Armaflex SS and AP Armaflex Sheet. Product shall meet the requirements as defined in ASTM C 534, "Specification for preformed elastomeric cellular thermal insulation in sheet and tubular form."
- C. Insulation material shall have a closed-cell structure to prevent moisture from wicking, which makes it an efficient insulation.
- D. Insulation material shall be manufactured without the use of CFC's HFC's or HCFC's. It shall also be formaldehyde free, low VOC's, fiber free, dust free and resists mold and mildew.
- E. Materials shall have a flame spread index of less than 25 and a smoke-developed index of less than 50 when tested in accordance with ASTM E 84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.
- F. Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft²-°F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
- G. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A, latest revision. The material shall be manufactured under an independent third party supervision testing program covering the properties of fire performance, thermal conductivity and water vapor transmission.

2.2 DUCT INSULATION (INDOORS)

- A. All leakage testing of ductwork to be insulated shall be completed, and resealing of areas found to not be tight, prior to the application of any insulation materials.
- B. Supply, and outside air intake ductwork shall be insulated with a minimum of 2" thick R-8 (as rated on manufacturer's packaging) fiberglass duct wrap insulation when located within interior unconditioned spaces such as duct shafts and above ceilings.
- C. Duct insulation shall be continuous through wall openings and sleeves.
- D. Insulation shall be as manufactured by Owens Corning or approved equal. Insulation shall have a foil-faced vapor barrier.
 - 1. Spiral and Oval ductwork installed exposed within indoor spaces shall be internally sound lined with 1".
 - a) Duct sizes indicated are inside clear dimension, increase overall duct size by 2" to accommodate for duct lining.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Refer to the manufacturer's written installation instruction & product data sheets for additional information, and for product specific installation requirements and instructions.
- B. All testing of ductwork and piping to be insulated shall be completed prior to the application of any insulation materials.
- C. All surfaces to be insulated shall be cleaned of all scale, rust, oil, and foreign matter and shall be dry and free of frost prior to and during application of insulation.
- D. All insulation and accessory materials shall be stored in an area that is dry and protected from the weather before and during insulation application.
- E. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- F. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- G. 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.

- H. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- I. Install multiple layers of insulation with longitudinal and end seams staggered.
- J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- K. Keep insulation materials dry during application and finishing.
- L. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- M. Install insulation with least number of joints practical.
- N. 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.
- O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- P. 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 on center.
 - 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 on center.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement after start-up.
- S. 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.
- T. 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.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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 shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
 2. Inspect field-insulated equipment, 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 one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 3. 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.

3.4 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 1. Indoor, concealed supply, return, exhaust, and outdoor air.
 2. Indoor, exposed supply, return, exhaust, and outdoor air located in non-conditioned space.
 3. Indoor, concealed supply, return, exhaust, and outdoor air located in non-conditioned space.
 4. Indoor, exposed supply and outdoor air located in conditioned space.
- B. Items Not Insulated:
 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.

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 Refrigerant Piping
 - 1. Install insulation over pipe, fittings, valves, and specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using 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. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a paintable jacket.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION FOR GREASE DUCTS

- A. Install insulation in strict accordance with the manufacturer's instructions to maintain FM and UL listings.
- 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 fire stopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Fire stopping."

3.7 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.
 - 3. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 4. Extend jacket of outdoor insulation beyond roof flashing at least 2 inches below top of roof flashing.
 - 5. 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. 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 Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. 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 (50 mm).
 2. Pipe: Install insulation continuously through floor penetrations.
 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.8 CELLULAR-GLASS INSULATION INSTALLATION

- 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 factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches on center.
 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but 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 Fittings and Elbows:
1. Install preformed sections of same material as 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 sections of cellular-glass insulation. Secure insulation materials with wire or bands.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- 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 Fittings and Elbows:
1. Install mitered sections of pipe insulation.

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.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed 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.

3.10 MINERAL-FIBER INSULATION INSTALLATION

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 on center.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but 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 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.

C. Blanket Insulation Installation on Ducts and Plenums:

1. Secure with adhesive and insulation pins.
2. At volume damper and duct access door locations, cut insulation back to expose damper adjusters and access doors. Tape seal insulation to duct. Provide an insulation "Door" to cover the access point and mark the "Door" with highly visible fluorescent marker or tape.
3. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
4. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
5. 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 on center.

- b. On duct sides with dimensions larger than 18 inches, place pins 16 inches on center. 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 over-compress 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.
6. 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 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch on center. 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 shall 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 2 times the insulation thickness but not less than 3 inches.
7. 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 on center.
8. 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.
9. 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 on center.
- D. 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 100 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 on center.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches on center. 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 over-compress 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 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch on center. 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 shall 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 2 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 on center.

3.11 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
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.

3.12 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

3.13 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

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.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.14 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 on center. and at end joints.

3.15 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.

END OF SECTION 230700

SECTION 23 08 00 - HVAC SYSTEM COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

- 1.1 The work provided under this Division as described in this Specification is included in the scope of the Commissioning activities required to meet the Owner's goals.
- 1.2 RELATED DOCUMENTS
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this commissioning requirement.
 - B. ASHRAE Guideline 1-2007, HVAC&R Technical Requirements for the Commissioning Process.
 - C. Project OPR and BOD, for reference information only.
 - D. In addition to the drawings and general provisions of the contract, commissioning requirements are defined in the following sections:
 - 1. Section 019113 – General Commissioning Requirements
 - 2. Section 070800 – Commissioning of Thermal Moisture Protection
 - 3. Section 080800 – Commissioning of Openings
 - 4. Section 220800 – Plumbing Systems Commissioning Requirements
 - 5. Section 260800 – Electrical System Commissioning Requirements
 - 6. Section 230593 – Testing, Adjusting and Balancing for HVAC
 - 7. Section 230900 – Instrumentation and Control for HVAC
 - 8. Section 230993 – Sequence of Operation for HVAC Controls
- 1.3 SUMMARY
- A. INFORMATION COVERED IN THIS SECTION IS THE RESPONSIBILITY OF THE MECHANICAL CONTRACTOR AND THEIR ATC AND TAB SUBCONTRACTORS.
 - B. This section defines commissioning requirements for the following HVAC&R (Heating, Ventilation, Air-Conditioning and Refrigeration) systems, assemblies, and equipment:
 - 1. Energy supply systems.
 - 2. Heat generation systems.
 - 3. Cooling generation systems.
 - 4. Central-station air-handling systems.
 - 5. Air and refrigeration distribution systems.
 - 6. Heating and cooling terminal and unitary equipment.
 - 7. Energy Recovery Equipment.
 - 8. HVAC controls.
 - 9. TAB verification.
 - C. General commissioning requirements and CxA responsibilities are described in Division 01 Section 019113 and are therefore not repeated in this Section.
- 1.4 DEFINITIONS
- A. Commissioning Plan: A document, prepared by the CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
 - B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
 - C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
 - D. Commissioning Team: The individuals who through coordinated actions are responsible for implementing the commissioning process.

- E. Data logging: The monitoring and recording of flows, currents, status, pressures, etc., of equipment using stand-alone data recorders separate from the control system or the trending capabilities of control systems.
- F. Deferred Performance Tests (DPTs): Performance tests that are performed, at the discretion of the CxA, after substantial completion, due to partial occupancy, equipment operability, seasonal requirements, design, or other site conditions that disallow the test from being performed.
- G. Deficiency, Non-Compliance, Non-Conformance: A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the contract documents.
- H. DDC: Direct digital controls.
- I. Factory Testing: Testing of equipment on-site or at the factory, by factory personnel, with or without an owner's representative present.
- J. Functional Performance Test (FPT): Functional tests that are executed by the TC, and witnessed by the CxA, following the protocol written by the CxA that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. Performance testing includes the dynamic functions and operations of equipment and systems using manual or monitoring methods under various levels of operation. Systems are tested under various modes, such as during low cooling loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to respond as the sequences state.
- K. HVAC: Heating, Ventilating, and Air Conditioning.
- L. 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.
- M. Official: State or Local official having jurisdiction over the HVAC&R systems
- N. Pre-Functional Checklists (PFC): Pre-functional checklists are prepared by the CxA and completed by the Trade Contractors (TC) to verify the proper installation of new or relocated HVAC equipment in accordance with industry practices.
- O. Pre-Functional Testing (PFT): Testing performed by the Trade Contractors (TC) to verify system readiness. Pre-Functional Testing is to be completed as part of startup of the equipment in preparation for Functional Performance Testing.
- P. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
- Q. Quality Based Sampling: A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.
- R. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
- S. Seasonal Performance Tests: Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.
- T. Startup: The initial starting or activating of dynamic equipment, including completing construction checklists.
- U. Systems Manual: A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the owner during the occupancy and operations phase.

- V. "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.
- W. TAB: Testing, Adjusting, and Balancing.
- X. Training Plan or Instruction Program: A written document that details the expectations, schedule, and deliverables related to the training of project operating and maintenance personnel, users, and occupants.
- Y. Trending: The monitoring, by a building management system or other electronic data gathering equipment, recording, and analyzing of the data gathered over a period of time.

1.5 CONTRACTOR REQUIREMENTS

- A. Meet all the requirements of Section 01 91 13 "General Commissioning Requirements." In addition to component and systems level commissioning of the work listed, participation in inter-system testing and integrated commissioning of interrelated work is required. For list of all commissioned work see Section 01 91 13 "General Commissioning Requirements."
- B. Provide factory start-up and required technical personnel for participation in Owner's Commissioning.
- C. Construction and Acceptance Phase:
 - 1. Provide submittal data, commissioning documentation, O&M data and training related to Commissioning, including information from equipment suppliers.
 - 2. Attend meetings necessary to facilitate the Commissioning process (refer to Section 01 91 13 and PART 3 - EXECUTION of this specification for more information on meetings).
 - 3. Review the commissioning Issues Log for items related to contracted work and assist the commissioning team in addressing and resolving these issues.
 - 4. Complete commissioning checklists provided by Stephen Turner Inc. and return completed checklists to the Commissioning Team. Startup checklists may require specific input from the Equipment Supplier such as a copy of the Manufacturer's Startup Checklist and Factory Start-up Reports.
 - 5. Address any available Owner and Design Professional punch list items before final commissioning testing. Discrepancies and problems (differences between required and observed performance) shall be remedied before commissioning testing of the respective systems.
 - 6. Complete air system TAB with all discrepancies and problems remedied before commissioning testing of the respective air or water-related systems.
 - 7. Execute commissioning tests, which will be developed and led by the CxA. Testing will start at the components level, will proceed to the system level, and will end with inter-system testing.
 - 8. Correct issues (differences between required and observed performance) as interpreted by CxA, the Owner/OPM, and the A/E team and retest the equipment.
 - 9. Provide training of the Owner's operating staff, as required in PART 3 of this specification and elsewhere in the Contract Documents.
 - 10. Assist, communicate, and cooperate with the CxA. Provide skilled technicians familiar with this building and installed equipment to assist with commissioning testing.
- D. Warranty Period
 - 1. Execute seasonal or deferred commissioning testing, as applicable, witnessed by the CxA. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.6 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of the HVAC&R systems shall include all equipment and components associated with the Heating, Ventilation, Air-Conditioning and Refrigeration systems. These shall include, but are not limited to:
1. Indoor Fan Coil Units (IDUs) (30% sample test set of each type as selected by the A/E)
 2. Split System Air Conditioning (100% test set)
 3. Building Automation System/Automatic Temperature Controls, including operator stations, displays, alarms, metering, monitoring, sensors and control systems programming and trending (100% test set)

1.7 SUBMITTALS

- A. Refer to Division 01 Section 011000 "Submittal Procedures" for specific requirements.
- B. In addition, provide the following:
1. Certificates of readiness.
 2. Certificates of completion of installation, prestart, and startup activities (PFC).
 3. All contractor and equipment vendor/manufacturer startup and test reports and service tickets for equipment and systems.
 4. Completed Pre-Functional Testing Reports.
 5. Duct and Piping Pressure Test Reports (REQUIRED - duct pressure testing is to be included by the MC/TAB contractor and witnessed by the CxA)
 6. Testing, Adjusting, and Balancing Reports
 7. O&M manuals.
- C. Control Drawings Submittals
1. The control drawings shall have a key to all abbreviations.
 2. The control drawings shall contain graphic schematic depictions of the systems and each component.
 3. The diagrams shall include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 4. Provide a full points list with at least the following included for each point:
 - a. Controlled system
 - b. Point abbreviation
 - c. Point description
 - d. Display unit

1.8 COORDINATION

- A. Coordination of the Cx process is the responsibility of all Cx Team members.
- B. The CxA coordinates the commissioning activities through the construction manager or general contractor. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- C. The CxA, through the Owner or CM, will provide sufficient notice to the contractor for scheduling commissioning activities with respect to the Owner's participation. The CM will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. The mechanical contractor shall provide sufficient notice to the CxA for scheduling attendance at all testing activities including duct and pipe pressure testing, and equipment start-up.

1.9 REMOBILIZATION AND RETESTING FEES

- A. In general, CxA Functional Testing will include one test of each system or equipment. The cost of any additional testing, if required due to differences between required and observed performance, will be submitted to the Owner for review and direction. Following Owner review, the cost for additional testing to verify that performance in accordance with the design intent may be deducted from the Contractor's final payment by the Owner.
- B. In the event that a CxA site visit scheduled in advance with the Contractor and testing is unable to be performed through no fault of the Owner, and the CxA is not notified within 48 hours prior to the scheduled visit, the cost of the travel and time may be deducted from the contractor's final payment by the Owner.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall furnish all standard testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC&R system and controls system in Division 23, including for equipment specific to and used by TAB in their commissioning responsibilities.
- B. Refer to Division 01 Section 019113 "General Commissioning Requirements" for a detailed description of test equipment requirements.

PART 3 - EXECUTION

3.1 TRADE CONTRACTOR'S COMMISSIONING TEAM RESPONSIBILITIES

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for commissioning team member roles and responsibilities.
- B. Each trade including all Sub-contractors, Tier Contractors, manufacturers' start-up personnel, as well as direct Equipment Suppliers shall designate personnel to be responsible for coordinating commissioning activities with the Commissioning Authority as required in Section 01 91 13 "General Commissioning Requirements."
- C. The responsibilities of this contractor include, but are not limited to:
 - 1. Include any costs for Commissioning Process activities for administration and execution in the contract price.
 - 2. Include Commissioning Process requirements and activities in all subcontracts and equipment purchases.
 - 3. Ensure the cooperation and participation of all subcontractors and manufacturers of equipment or systems to be commissioned.
 - 4. Attend Commissioning Team meetings.
 - a. Attendance of regularly scheduled commissioning meetings is required by at least one (1) representative from the Contractor(s) for the systems being commissioned during delivery, installation, and start-up, and when checklists and tests are being performed.
 - b. As specific issues arise, a representative from each direct equipment supplier, and each supplier of other equipment not adequately represented by technical personnel from the responsible Contractor will be required to attend the meeting to assist in resolutions.
 - 5. Include Cx-related milestones in the construction schedule.
 - 6. Implement the training program as described in the Contract Documents. Coordinate related activities with the CxA.

7. Provide submittals to the Owner, Design Team, and CxA as detailed in the Common Work Results for HVAC 230500 and in this section.
 8. Respond to and resolve issues identified in the Cx Issues Log.
 9. Notify the CxA when systems and assemblies are ready for installation verification and testing. For repetitive assemblies, notify the CxA upon the completion of the prototype for a First Piece or Mock-Up review.
 10. Notify the OPM and Architect when duct systems are ready to be pressure tested by the TAB Subcontractor and assist as required for the testing.
 11. Notify the OPM and Architect when systems and equipment is ready for testing, adjusting, and balancing and assist as required.
 12. Complete Pre-Functional Checklists (PFC) and make corrections as required. See more detailed description in this section.
 13. Complete Pre-Functional Testing (PFT)) and make corrections as required. See more detailed description in this section. Complete Pre-Functional test procedures. Pre-Functional Testing is to be completed as part of startup of the equipment in preparation for Functional Performance Testing. Functional testing will not take place until all PFTs have been fully executed and completed reports have been submitted to the CxA.
 14. Functional Performance Test (FPT): Once Pre-Functional Tests are complete, functional test verification will be scheduled and demonstrated in the presence of the CxA.
 15. Maintain the Project Record Documents in accordance with the requirements of the Contract Documents.
- D. The suppliers of major equipment are required to support the Commissioning Team in the following manner:
1. Provide all information required for the proper Start-up and Operation and Maintenance of the system or assembly in the initial submittal, as detailed in the Contract Documents.
 2. Provide the requirements to maintain the warranty in the initial submittal, as detailed in the Contract Documents.
 3. Coordinate and provide results of all factory tests required in the Contract Documents.
 4. Participate in the training process as detailed in the Contract Documents.
 5. Demonstrate operation and performance of equipment and assemblies as detailed in the Contract Documents.
 6. Coordinate and participate in set-up of programming features with the MC, ATC, and TAB contractors.

3.2 GENERAL DOCUMENTATION REQUIREMENTS AS A PREREQUISITE TO TESTING

A. Submittals

1. Provide submittals to the as detailed in the Common Work Results for HVAC 230500. Additional requirements for this Section are below.
2. Testing, Adjusting, and Balancing:
 - a. The TAB Contractor shall submit a project-specific TAB Submittal six (6) weeks prior to starting TAB work. This plan will be developed after the TAB Contractor has some familiarity with the systems and associated control systems. The Submittal shall address each system and component, and shall include but not be limited to items below.
 - b. TAB Contractor's certifications and credentials to perform the contracted work.
 - c. Certification that the TAB has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.

- d. The identification and types of measurement instruments to be used and their most recent calibration date.
 - e. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data to be gathered for each.
 - f. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - g. Final test report forms to be used.
 - h. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / sub-main proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.
 - i. List of all air flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - j. The TAB plan must include project specific takeoffs of all the DP and other values required to be determined during TAB.
 - k. Details of how total flow will be determined.
 - l. Air: sum of terminal flows or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - m. Specific procedures that will ensure that air systems are operating at the lowest possible pressures and provide methods to verify this.
 - n. Confirmation that TAB contractor understands the outside air ventilation criteria under all conditions.
 - o. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
 - p. Details of methods for making any specified coil or other system plant capacity measurements. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
 - q. Phasing plan for performing TAB work by floor or area, and details regarding specified deferred or seasonal TAB work.
 - r. Details of any specified false loading of systems to complete TAB work.
 - s. Procedures for verifying required room pressure differentials.
 - t. Details of any required interstitial cavity differential pressure measurements and calculations.
 - u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - v. Plan for formal progress reports (scope, frequency and distribution list).
 - w. Plan for formal deficiency reports (scope, frequency and distribution list).
 - x. Procedures for addressing partial build-out, diversity, and part load issues including false loading or other approaches where allowed.
 - y. Methods to make all specified refrigerant coil and system capacity measurements.
 - z. Specific procedures to ensure air distribution systems operate at the lowest possible pressures and the methods to verify and document this.
 - aa. Proposed points for sound measurements including proposed measurement methods.
3. HVAC Submittals:

- a. Include ranges for all thermometers, pressure gauges, and other measuring devices.
 - b. Provide performance data including range, accuracy, data storage, local read-out, and data connections for each meter type submitted.
 - c. Include service designation for each individual system, including each duct system and piping system, fittings and joining materials, each insulation system, all valves, all piping specialties, and all accessories. These shall be presented in table format, to clearly indicate where each type of material will be used for each system. Generic cut sheets that do not indicate the specific application are not acceptable. Copies of the project specifications are not acceptable.
 - d. Provide detailed product data for each piece of equipment including capacities, electrical components and requirements, including all specified product attributes.
 - e. Provide performance curves (full and part-load as applicable) for each fan and piece of unitary equipment submitted.
 - f. Provide Manufacturers' detailed installation requirements clearly marked (arrow, underline, circled, etc.) to indicate only the intended item.
 - g. Provide Manufacturers' detailed start-up requirements and procedures clearly marked (arrow, underline, circled, etc.) to indicate only the intended item.
 - h. Provide Manufacturers' operation instructions clearly marked (arrow, underline, circled, etc.) to indicate only the intended item.
 - i. Provide Manufacturers' recommended maintenance and troubleshooting procedures clearly marked (arrow, underline, circled, etc.) to indicate only the intended item.
 - j. Provide Warranty and clear statement of Owner's obligations to maintain equipment to preserve warranty.
- B. Red-lined and As-Built Drawings
1. Provide submittals as detailed in the Common Work Results for HVAC 230500. Additional requirements for this Section are below.
 2. The contractor shall verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 3. Preliminary red-lined drawings shall be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 4. The Contractor shall incorporate changes resulting from Functional Testing into the final as-built drawings, which will be created from the red-lined drawings.
 5. This contractor, as defined in the Contract Documents, shall generate the As-Built drawings.
 6. All red-lined drawings shall be available for review on-site by the Owner and the CxA.
- C. Operation and Maintenance Data
1. Provide submittals to the as detailed in the Common Work Results for HVAC 230500. Additional requirements for this Section are below.
 2. Within 4 weeks of completing the submittal review process ("Approved" Product or Shop Drawing Submittal), provide final, or if that is not yet available, draft electronic format O&M Manual to the CxA for use in developing Functional Performance Tests.
 3. Final Controls O&M Manuals shall include:
 - a. Component installation, operation, and maintenance instructions for each building level, floor level, and equipment level controller, integrator, or field panel.
 - b. Calibration requirements and intervals by sensor and positioned or actuator type.
 - c. Specific instructions on how to perform all functions, access all features, and switch to each mode in the workstations and controllers.

- d. Software version and security update requirements.
 - e. Sequences of operations for each piece of equipment.
 - f. Final points list including cross-references to final room numbers and equipment designations provided by the Owner during Construction.
 - g. Full as-built file of all schedules and setpoints in electronic format as specified in the contract documents.
 - h. Actual room numbers as posted in the building shown on controls drawings.
4. The CxA will review the O&M literature once for conformance to project requirements.
- D. Equipment Start-up Reports
1. For all commissioned systems and equipment, one copy of the equipment manufacturer's or Contractor's start-up report shall be provided to the CxA for review and to document that the equipment is installed, operational, and ready for commissioning testing.
 2. Copies of additional testing performed including but not limited to duct pressure tests, vibration analysis required elsewhere in the specifications shall be provided to the CxA.
 3. For all third party testing required elsewhere in this specification or by code, provide test reports to the CxA for review and to document that the testing has been performed. Coordinate dates for third party testing in advance with the CxA to allow commissioning personnel to witness selected tests.
 4. The Contractor shall ensure that the actual room numbers as posted in the building are used in the controls programming and point names.
- E. Systems Manual Requirements:
1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
 2. Documents for the Systems Manual shall be supplied to the CxA by each trade in the formats determined by the CxA.
 3. Final approved versions of the following information for the Systems Manual:
 - a. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - b. As-Built System Diagrams
 - c. Verified Record Drawings
 - d. Test Results not otherwise included in Cx Record
 - e. Periodic Maintenance Information for computer maintenance management system
 - f. Recommendations for recalibration frequency of sensors and actuators
 - g. Training Records, Information on training provided, attendees list, and any on-going training
 4. This information shall be organized and arranged by building system.
 5. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.
- F. PREFUNCTIONAL CHECKLISTS
1. The Pre-Functional Checklist shall be completed as part of the TC's initial checkout of the equipment to ensure that the equipment installation is complete and is prepared for Pre-Functional Performance Testing.
 2. With assistance from the installing contractors, the CxA will prepare Checklists for all commissioned components, equipment, and systems.

3. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.
 - a. Return draft construction checklist review comments within [10] days of receipt.
4. When review comments have been resolved, the CxA will provide final construction checklists, marked "Approved for Use, (date)." Use only Approved checklists.
5. The construction checklists, developed by the CxA, are to be completed by this contractor (or its subcontractors), before and during the startup process and verified by the CxA. Provide completed copies to the CxA at regular intervals for verification.

3.3 PRE-FUNCTIONAL TESTING

- A. In order to verify that the systems and equipment are ready for final Functional Performance Testing witnessed by the CxA, the Contractor will complete the Pre-Functional Checklists and perform Pre-Functional Testing independent of the CxA. Pre-Functional Testing shall consist of performing the complete Functional Testing with test requirements provided by the CxA. Through this process, the Contractor will validate the test procedure and provide a marked-up version of the test complete with results and identification of the specific units tested.
- B. Perform pre-functional testing for all systems and sequences to confirm proper operation of programs and equipment for all operating modes, including but not limited to, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, special sequences, and alarm conditions.
- C. Inspect and verify the position of each device and interlock identified on checklists.
- D. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- E. The contractor shall install testing and measuring instruments and logging devices to record test data as directed by the CxA.
- F. Once a completed test is provided indicating successful operation of the system, the CxA will schedule the Functional Testing as described below.
- G. Functional testing will not take place until all PFTs have been fully executed and completed reports have been submitted to the CxA.

3.4 FUNCTIONAL TESTING GENERAL REQUIREMENTS

- A. The performance of the testing of all commissioned equipment and systems is the responsibility of the Contractors. The CxA will develop the functional performance tests with the assistance of the installing contractors, and upon the successful completion of Pre-Functional Testing as described above, will coordinate the testing process, and witness the tests that are performed by the Contractors. In addition, the CxA will prepare plans for, assist with execution of, and document tests of commissioned equipment overseen by regulatory authorities and ensure that such tests meet the rigor desired by the Owner. The CxA will coordinate the retesting of equipment until satisfactory performance is achieved.
- B. The functional performance testing will include operating the systems and components through each of the written sequences of operation, other significant modes and miscellaneous alarms, power failure, and security alarm when impacted by and interlocked with commissioned equipment. Sensors and actuators shall be calibrated during construction check listing by the installing contractors and spot checked by the CxA during functional testing. Tests on HVAC equipment shall be done, if possible, in their proper operating season (cooling in summer, heating in winter). Any equipment that operates in both seasons, such as the heat pumps, should ideally be tested in both seasons. However, if this is not possible, some manipulation of setpoints and control points will be done to simulate the necessary conditions. Functional testing will be done using conventional manual methods, control system trend logs, and stand-alone data loggers as required to provide a high level of confidence in proper system function, as deemed appropriate by

- the CxA and the Owner. A report will be provided that includes all of the issues identified during the testing process.
- C. Provide qualified technicians, instrumentation, tools, and equipment to test performance of air, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal and unitary equipment.
 - D. Provide qualified technicians, instrumentation, tools, and equipment to test performance of acoustic, vibration isolation, and seismic controls.
 - E. Certify to the CxA that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents based on Pre-Functional Testing having been completed by the Mechanical contractor and/or their subcontractors, for each component and system prior to scheduling Cx Functional Testing.
 - 1. Each direct equipment supplier, and each supplier of other equipment not adequately represented by technical personnel from the responsible Contractor shall assist the installing contractor in commissioning testing.
 - F. Certify to the CxA that HVAC&R instrumentation and control system installation including all components and programming have been completed and calibrated, that they are operating according to the Contract Documents based on pre-functional testing of each sequence, points are set up and are being trended in the BMS, and that pretest set points have been recorded.
 - 1. The Controls Contractor shall provide signed and dated certifications for the completion of the programming, point to point ring outs, and check out of each controlled device, equipment, and system prior to functional performance testing. Any programming to be completed during functional performance or inter-system testing shall be clearly indicated.
 - 2. The Controls Contractor shall implement control system trend logs at the direction of the CxA prior to the start of on-site functional performance testing. A comprehensive trend review will be performed prior to any on-site functional performance testing, to confirm that all systems appear to be functioning properly before physically traveling to the project site. The controls contractor must provide a minimum of 48 hours of trends of all requested control points at 1 minute time intervals starting on a Sunday and ending on a Monday.
 - 3. As a component of the test procedures, the CxA will identify specific system trends to be set up and then analyze the trend and monitoring data as a method of verifying performance.
 - G. Certify that testing, adjusting, and balancing has been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work completed and approved, and any required rebalancing has been completed.
 - H. Additional Requirements for Testing Specified Elsewhere
 - 1. HVAC Piping Pressure Testing.
 - 2. HVAC Duct Pressure Testing.
 - 3. The Construction Manager (CM) shall provide a copy of the proposed test procedure to the CxA for review.
 - 4. The CM shall notify Stephen Turner Inc. at least two days in advance of the date and time the test is scheduled.
 - 5. The CM shall provide copies of field and final test results to the CxA for review for consistency with the Owner's Project Requirements.
 - 6. Energy Supply System Testing: Provide QUALIFIED technicians, instrumentation, tools, and equipment to test performance of fuel systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
 - I. General Test Procedures:

1. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
2. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
3. Tests shall be performed using design conditions whenever possible.
4. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
5. The CxA may direct that set points be altered when simulating conditions is not practical.
6. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
7. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
8. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 FUNCTIONAL TESTING PROCEDURES

- A. Acceptance criteria and test details will be in accordance with the related sections including Division 01 Section 019113 Commissioning General Requirements.
- B. Any equipment or system that cannot be adequately tested at the time of the initial testing due to seasonal operating issues will be retested in their primary operating season. Whenever possible, systems will be tested under load to verify system capacity and function.
- C. The CxA will witness the Initial tests. Each contractor will be responsible, as required, to put the system in various modes of operation, to fix minor problems found during the test (i.e. problems that can be fixed without delaying the completion of the test), and to witness the testing. Where the CxA develops a procedure for the test, the contractor shall implement the test to the satisfaction of the CxA.
- D. The CxA will provide all commissioning team members (construction manager, contractors, Design Professional, Owner, etc.) the commissioning test procedures prior to scheduled testing. If no comments are received from a particular commissioning team member, that shall constitute acceptance of the commissioning test procedures as is.
- E. The CxA shall schedule and witness the testing once all commissioning checklists (with exception of the TAB Checklists) have been completed by the contractors and accepted by the CxA.
- F. INITIAL TESTING – Building Automation Systems
 1. The emphasis of the initial commissioning testing is on the building automation system performance, since many of the building functions have the control system as a common component.
 2. Included in this work will be sample-based verification of instrument and sensor calibration, access to components, labeling of devices, clear sequences and shop drawings.
 3. The verification of the control system will be accomplished as an on-going task during construction to identify and resolve systemic issues early in the project.

4. The building automation system operation shall be sufficiently operational prior to the TAB of the system. It is understood that a portion of the final building automation system startup occurs in conjunction with the TAB work. The intent of this requirement is for the TAB work to be productive and not be hampered by a control system that is not sufficiently functional.
 5. The commissioning testing of the control system will utilize the controls system instrumentation for testing. Therefore, the first portion of the control system testing will be verification of the sensors, inputs and outputs.
 6. Point-to-Point Verification: All wiring shall be checked out by the controls contractor from end to end, point to point, from field to computer screen to ensure correct connection and a system free from wiring deficiencies. The Controls Contractor shall document this verification and provide to Stephen Turner Inc. prior to start of Functional Performance Testing.
 7. Commissioning verification of sensors will be made using the sampling method; an exhaustive re-test of all control system inputs and outputs will not be conducted by Stephen Turner Inc. Prior to Stephen Turner Inc. verification, the control contractor shall be responsible for complete input/output checkout quality assurance.
 8. Sensor and Actuator Calibration, General:
 - a. This section is included to emphasize the importance of the control contractor calibrating the instrumentation, and to make clear the requirement for same; and that "factory calibration" or "calibration by exception" is not acceptable.
 - b. All field-installed temperature, relative humidity, CO2, and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the Owner in advance. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided to Stephen Turner Inc. need not be field calibrated.
 - c. All procedures used shall be fully documented, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
 9. Sensor Calibration Methods
 - a. All Sensors. Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end.
 - b. Sensors without Transmitters. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor is within the specified tolerances. If not, calibrate or replace sensor.
 - c. Sensors with Transmitters. Connect a signal generator. Adjust transmitter zero and span to match the signal generator until the ammeter reads 4 mA. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading is within the specified tolerances. If not, replace sensor and repeat.
 10. Damper Stroke Setup and Check
 - a. Set fans to normal operating mode. Command damper closed, visually verify that the damper is closed and adjust output zero signal as required. Command damper open, verify position is full open and adjust output signal as required. Command damper to a few intermediate positions. If actual damper position doesn't reasonably correspond, repair or replace actuator.
 - b. Closure for normally closed dampers. Disconnect power to the actuator motor and verify the damper moves to full closed position. Restore to normal.
 - c. Normally open dampers: disconnect power to the actuator motor and verify the damper moves to full open position. Restore to normal.
- G. The systems in the building will be operated in different modes of operation to verify the control system responds properly. This testing provides both the Owner and Contractor with

documentation that the control system was operating properly at Project Acceptance. The tests include but are not limited to:

1. Sequence of control for:
 - a. Central Air Distribution Systems
 - b. Local Air Distribution System
 - c. VRF systems
2. Operator's Workstation graphics display
3. Trend logs
4. Status review screens, out of bounds checks, and alarming

H. INTERMEDIATE TESTING – Testing, Adjusting, and Balancing

1. The TAB contractor, upon request by the CxA if necessary during system troubleshooting, shall provide the CxA with the technician(s) who accomplished the TAB, along with the specific equipment used for the TAB, to verify and re-test between 10% and 20% of the TAB final report. Included in this work will be:
 - a. Sample-based verification of measured quantities
 - b. Review of firm qualifications
 - c. Review of instrument calibration records
 - d. Review of basic procedures. Particular emphasis will be placed on avoiding the use of iterative methods (repeat measurements) acknowledging the fact that changes in branch flows have an overall system effect.
2. The TAB Contractor shall provide the field reports or draft TAB reports to the CxA within one week of completion for each system or area, before functional performance testing.
3. The TAB Contractor shall make skilled technicians and instruments used during TAB available to address functional performance test results that are at variance with TAB reports.

I. SYSTEM LEVEL TESTING

1. Additional commissioning testing will be conducted after testing of the control system and TAB work, but prior to occupancy of the building. This testing will provide both the Owner and Contractor with documentation that the system operated correctly according to the Owner's Project Requirements. These tests are typically performed at the room level, where a sample of rooms is selected for review.
2. The CxA will lead this portion of commissioning testing. Each Contractor will be responsible, as required, to put the system in various modes of operation, to fix minor problems found during the test (i.e. problems that can be fixed without delaying the completion of the test), and to witness the testing. Where the CxA develops a procedure for the test the Contractor shall implement the test to the satisfaction of the CxA.
3. Contractors shall attend and operate equipment during commissioning testing as required by the specific test being performed.
4. The CxA shall schedule and administer the testing once all commissioning checklists have been completed by the Contractors and accepted by the Commissioning Authority.

J. INTER-SYSTEM TESTING

1. Additional inter-system testing is required under the Owner's Commissioning process to ensure that work in this Division is properly interoperable with other work. Contractors shall participate in system level and inter-system testing. Testing will include operation under both normal power and emergency power where applicable; change-over and transition between different operating modes; and complete exercising of systems through all modes and sequences.
 - a. VRF systems

- b. Fire detection and life safety systems
- c. Metering system
- d. Plumbing systems including but not limited to Domestic Hot Water and pumps
- e. Tel/data systems
- f. Lighting controls, indoor and outdoor
- g. Power systems
- h. Emergency power systems, including recovery from utility power loss
- i. Shade systems

3.6 DEFICIENCIES

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for additional requirements pertaining to deficiencies, non-conforming conditions, cost of retesting, or failure due to manufacturing defects.
- B. If the failure rate of a similar family of equipment or devices is greater than 10%, the Owner shall be notified. The matter shall be addressed by the Owner, GC, CxA, and other applicable parties. The failure issue shall be resolved to the Owner's satisfaction.
- C. Each direct equipment supplier, and each supplier of other equipment not adequately represented by technical personnel from the responsible Contractor, shall also be required to assist the installing contractor in resolving commissioning issues.

3.7 APPROVAL

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for additional approval procedures.

3.8 DEFERRED TESTING

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for additional requirements pertaining to deferred testing.

3.9 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for additional owner training requirements.
- B. The Mechanical Contractor shall provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of mechanical equipment.
 - 1. Provide a training plan to the CxA prior to any training.
 - 2. A training agenda for each training session shall be submitted to the CxA one (1) week prior the training session.
 - 3. Training shall occur after functional testing is complete, unless approved otherwise by the Owner.

END OF SECTION 230800

SECTION 23 09 00 - INSTRUMENTATION AND SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. This Section includes control sequences for DDC monitoring and control of HVAC systems, subsystems, and equipment.
- C. See Division 23 Section 230800 "Commissioning of HVAC" for requirements that relate to this Section.
- D. See Division 26 for electrical installation requirements. Controls Subcontractor is responsible for all control wiring – including line and low voltage wiring.
- E. Refer to Specification Section 01 23 00 for Alternate pricing requirements.

1.2 DEFINITIONS

- A. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- B. Authorized Systems Integrator: A certification attained through an authorized distributor of the Johnson Controls Facility Explorer BAS for independent BAS Controls Contractors. Authorized Systems Integrators will be defined as either a Gold, Silver, or Bronze level ASI.
- C. Binary: A two-state system where an "ON" condition is represented by one discrete signal level and an "OFF" condition is represented by a second discrete signal level. Can be used interchangeably with the word "Digital."
- D. Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this BMS Subcontractor and to be interfaced to the associated work of other related trades.
- E. BMS Subcontractor: The Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS work. The term may be used interchangeably with: Automatic Temperature Control (ATC) subcontractor; Direct Digital Control (DDC) subcontractor; Temperature Controls Contractor.
- F. Control Sequence: A BMS programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives. Collectively the control sequences are referred to as Sequence of Operation.
- G. Direct Digital Control (DDC): The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- H. BMS Network: The total digital on-line real-time interconnected configuration of BAS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements

individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.

- I. Node: A digitally programmable entity existing on the BMS network.
- J. BMS Integration: The complete functional and operational interconnection and interfacing of all BMS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.
- K. Provide: The term "Provide" and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- L. PC: IBM-compatible Personal Computer from a recognized major manufacturer
- M. Furnish: The term "Furnish" and its derivatives when used in this Division shall mean supply at the BMS Contractor's cost to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BAS, calibrate, test, commission, warrant and document.
- N. Wiring: The term "Wiring" and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.
- O. Install: The term "Install" and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- P. Protocol: The term "protocol" and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.
- Q. Software: The term "software" and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BAS configurations.
- R. The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- S. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.

1.3 SUBMITTALS

- A. Product Data: For each control device indicated.
- B. Shop Drawings:
 - 1. Schematic flow diagrams.
 - 2. Power, signal, and control wiring diagrams.
 - 3. Damper schedule.
 - 4. Valve schedule.
 - 5. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
 - 6. Control System Software and Hardware details
- C. Software and firmware operational and warranty documentation.

- D. Field quality-control test reports.
- E. Operation and maintenance data.

1.4 SCOPE

- A. Provide manufacturer's controls. All mechanical systems shall be automatically controlled. Where no description of operation is indicated for a particular system or device, the contractor shall select appropriate control scenarios and review them with the engineer prior to proceeding. All controls shall be arranged and designed for maximum energy conservation.
- B. The DDC/ATC Subcontractor shall be responsible for installation of control devices furnished by equipment manufacturers and installed in the field.
- C. Interfacing control and monitoring of manufacturer supplied controls shall be by this contractor.
- D. Provide incidental 110V power wiring to panels and control transformers where not shown on electrical drawings.
- E. The DDC/ATC Subcontractor shall provide all low and line voltage wiring required for the installation and operation of the BMS. Refer to Division 26 for wiring standards and source of power.
- F. Alarms, where applicable and all interlocking wiring required shall be provided by the ATC Subcontractor.
- G. The DDC/ATC Subcontractor shall review and study all HVAC, Electrical, Plumbing, and Fire Protection drawings and entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc., he is required to provide. Numerous references to the ATC Subcontractor are made throughout this specification identifying work to be performed under this Section in addition to work specifically indicated under this paragraph.
- H. The controls systems shall be installed by competent control mechanics and electricians regularly trained by the manufacturer of the control equipment. All control equipment shall be the product of one (1) manufacturer and all ATC components shall be capable of interfacing with the HVAC equipment. The factory trained control contractor must maintain adequate staff and offer standard services to fully support the owner in the timely maintenance, repair, and operation of the control system. Contractors who do not maintain such staff and offer services or must develop some for this project are not acceptable. Bids from franchised dealers or others whose principal business is not the installation and service of temperature control systems will not be acceptable. The ATC contractor is responsible for providing software upgrades to maintain the system with the most up to date versions available at the end of the warranty period.

1.5 QUALITY ASSURANCE

- A. The DDC/ATC Subcontractor shall be regularly engaged in the engineering, programming, installation and service of total integrated building management systems.
- B. The DDC /ATC Subcontractor shall have a fully staffed branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24-hour, 7-day-a-week basis.
- C. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the HVAC Controls business for at least the last five (5) years.

1.6 SEQUENCE OF OPERATION

- A. Split system: Outdoor condensing units & associated indoor evaporator units:
1. The indoor evaporator unit shall operate off the manufacturer's wall-mounted simple MA thermostat to maintain the space cooling and heating setpoint.
 2. When the building is occupied, the split system shall be on, and the fresh air damper shall be open. The room cooling setpoint shall be 72°F, and heating setpoint shall be 68°F (adjustable).
 3. When the building is unoccupied, the split system shall be on, but running at the unoccupied setpoints, and the fresh air damper shall be closed. The room cooling setpoint shall be 75°F, and heating setpoint shall be 65°F (adjustable).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Equipment Controllers: Provide Manufacturer's controls. For the split system provide with wired simple ma controller thermostat.

2.2 THERMOSTATS (NON-DDC)

- A. Manufacturers:
1. Erie Controls.
 2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
 3. Heat-Timer Corporation.
 4. Sauter Controls Corporation.
 5. Tekmar Control Systems, Inc.
 6. Theben AG - Lumilite Control Technology, Inc.
- B. 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.
- C. 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.
- D. 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 air ducts with flanges and shields.
 2. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 3. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 4. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.

5. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- E. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:
 1. Reset: Manual.
 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- F. Room Thermostat Cover Construction: Provide sample for Owner approval.
- G. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- H. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft of coil surface.
- I. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.3 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 2. 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.
 3. 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 .
 4. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf .
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 1. Manufacturers:
 - a. Belimo Air Controls (USA), Inc.
 2. 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.
3. Coupling: V-bolt and V-shaped, toothed cradle.
 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 6. Power Requirements (Two-Position Spring Return): 24 / 120 / 230 V ac.
 7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 9. Temperature Rating: Minus 22 to plus 122 deg F.
 10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

2.4 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. TAMCO (T. A. Morrison & Co. Inc.).
3. Nailor
4. Greenhekck

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 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.

2.5 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. 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.
- B. Install guards on thermostats in the following locations:
 - 1. Entrances.
 - 2. Public areas.
 - 3. Where indicated on the drawings.
- C. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- E. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- F. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- G. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- H. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.3 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. Refer to the requirements of section 230800 "Commissioning of HVAC" for additional requirements.
- C. 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 controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 6. Test each system for compliance with sequence of operation.
 - 7. Test software and hardware interlocks.
- D. 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 pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 6. Check temperature instruments and material and length of sensing elements.
 - 7. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 - 8. 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.
- E. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 DEMONSTRATION

- A. Refer to Specification section 230800 "Commissioning of HVAC" for additional requirements.

- B. The BMS subcontractor shall be present onsite for Testing and Balancing activities and shall calibrate the control system based on these measurements.
- C. The BMS subcontractor shall complete point-to-point check and testing of all BMS work prior to commissioning. The BMS subcontractor shall then be present onsite for commissioning activities and shall demonstrate the functionality of the BMS to the commissioning agent. Deficiencies in the HVAC controls systems shall be rectified without delay.
- D. The Sequence of Operation and the Graphic User Interface shall be programmed by the BMS subcontractor based on the approved submittals. During commissioning, aspects of the approved sequence of operation or graphics may need optimization. Include 40 hours of labor to implement programming changes as directed by the Mechanical Engineer.
- E. The BMS subcontractor shall provide on-site training for owner's maintenance personnel to adjust, operate, and maintain the BMS. In addition, provide offsite factory training by the Johnson Controls Training Institute for (2) owner's maintenance personnel, 5-day course, "FX MSTP Field Controller Engineering" course or equal.

END OF SECTION 230900

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2. Suction Lines for Heat-Pump Applications: 325 psig.
 - 3. Hot-Gas and Liquid Lines: 325 psig.

1.3 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual 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.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L.
- B. Wrought-Copper Fittings: ASME B16.22.

- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. 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. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze.
 - 2. Packing: Molded stem, back seating, and replaceable under pressure.
 - 3. Operator: Rising stem.
 - 4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
 - 5. Seal Cap: Forged-brass or valox hex cap.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Working Pressure Rating: 500 psig.
 - 8. Maximum Operating Temperature: 275 deg F.
- C. Check Valves:
 - 1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 - 2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 - 3. Piston: Removable polytetrafluoroethylene seat.
 - 4. Closing Spring: Stainless steel.
 - 5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Maximum Opening Pressure: 0.50 psig.
 - 8. Working Pressure Rating: 500 psig.
 - 9. Maximum Operating Temperature: 275 deg F.
- D. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Copper spring.
 - 5. Working Pressure Rating: 500 psig.

- E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
 8. Manual operator.
- F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig.
- H. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- I. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- J. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240 deg F.

- K. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina or charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240 deg F.
- L. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina or charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240 deg F.
- M. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- C. ASHRAE 34, R-410A: Puron.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

- C. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- E. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications:
 - 1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 2. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 3. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.
- G. Safety-Relief-Valve Discharge Piping:
 - 1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 2. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 3. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at strainers if they are not an integral part of strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor.
- L. Install flexible connectors at compressors.

3.3 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 Shop Drawings.
- B. Install refrigerant piping according to 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 Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" 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 Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.

- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. 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.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
- V. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
 2. Test refrigerant piping and specialties. 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 Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage 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.

3.7 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.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.

4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
3. Division 23 Section "Vibration and Seismic Control for HVAC Piping and Equipment" for vibration and seismic control requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall 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."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2013.

1.3 SUBMITTALS

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

B. 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 of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.

E. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports or AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2013, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 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.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) 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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," 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. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "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."
- E. Square throat round heel elbows are not allowed. Any square throat round heel elbows found installed by this contractor will be ordered to remove and replace with square throat square heel elbows with vanes at no additional cost to the project.

2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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."

1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," 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 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 shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: 16 GAUGE Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, 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.

2.4 SEALANT AND GASKETS

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. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. 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.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated 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 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated 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.

2.6 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Ductmate Industries, Inc.
 - 3. Hilti Corp.
 - 4. Kinetics Noise Control.
 - 5. Loos & Co.; Cableware Division.
 - 6. Mason Industries.
 - 7. TOLCO; a brand of NIBCO INC.
 - 8. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction].
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. 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.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.["Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."]

3.2 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 1. Space lateral supports a maximum of 40 feet O.C., and longitudinal supports a maximum of 80 feet O.C.
 2. Brace a change of direction longer than 12 feet (3.7 m).
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT CLEANING

- A. Clean all new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 6. Provide drainage and cleanup for wash-down procedures.
 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

- A. Supply Ducts:
1. Ducts Connected to Fan Coil Units, and Heat Pumps:
 - a. Pressure Class: Positive 2-inch wg.
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 4-inch wg.
- B. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, and Heat Pumps:
 - a. Pressure Class: Positive or negative 2-inch wg.
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg
- C. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
 2. PVC-Coated Ducts:
 - a. Exposed to Airstream: Match duct material.
 3. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 4. Aluminum Ducts: Aluminum.
- D. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 with vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

- c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or welded.
- E. Branch Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: 45-degree entry.
 - 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 45-degree lateral.
 - b. Velocity 1000 to 1500 fpm: 45-degree lateral.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers and Remote Operated Volume Dampers
3. Control dampers.
4. Fire Dampers.
5. Flange connectors.
6. Turning vanes.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Flexible ducts.
10. Duct accessory hardware.
11. Louvers

1.2 SUBMITTALS

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

B. 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 and Remote Operated volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - e. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems", and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. 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.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and top grade finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. 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.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.
 - 4. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 4-inch wg.
- E. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.
- F. Blades: Multiple opposed blades, with sealed edges.
- G. Blade Action: Opposed Blade.
- H. Blade Seals: Low leak, Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Galvanized steel.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Bird.
9. 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. C & S Air Products.
 - b. Air Balance Inc.; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
2. **Low leakage rating**, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - 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-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & S Air Products.

- b. Air Balance Inc.; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
 2. **Low leakage rating**, with linkage outside airstream.
 3. Suitable for horizontal or vertical applications.
 4. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with 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. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Axles: Galvanized steel.
 7. Tie Bars and Brackets: Aluminum.
- C. Jackshaft:
1. Size: 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.
- D. Manual 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.
- E. Remote Operated Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & S Air Products.
 - b. Air Balance Inc.; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
 2. **Low leakage rating**, with linkage concealed in frame.
 3. Suitable for horizontal or vertical applications.
 4. Frames: Steel hat-shaped 13 gauge channels; frames with 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. 6" 16-gauge triple v, opposed blade, or single blade.
6. Blade Axles: ½" plated steel hex.
 7. Bearings: Synthetic
 8. Sleeve: Optional 20 gauge 10" long
- F. Remote Operated Damper Hardware:
1. Control Shaft: 1/2" x 3" round drive axle with a control arm/screw-drive assembly factory installed on a stand-off bracket attached to an 10" x 20 ga. side plate secured to the damper frame.
 2. Remote Control Cable Assembly: 5/32" Ø x length to suit application cable with 3/16" allen hex-head drive, 2" wide steel mounting bracket, 15/16" x 1-1/2" long round plastic tube and optional nickel plated steel finishing plug.
 3. Include tee-handle hex tool for operator.
 4. Label finishing plug to identify service.

2.4 CONTROL DAMPERS

- A. Control dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Basis of design for outside air dampers is Greenheck model VCD-34. Basis of design for return air dampers is Greenheck model VCD-33.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. C&S Air Products
 2. Greenheck Fan Corporation.
 3. Nailor Industries Inc.
 4. Ruskin Company.
- C. Dampers shall consist of a 16 ga galvanized steel channel frame with 5 in depth; airfoil shaped, galvanized steel double skin construction blades 14 ga equivalent thickness filled with 0.5 in fiberglass insulation; blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper; 0.5 in dia. Plated steel axles turning in synthetic sleeve bearings; extruded silicone rubber blade seals for 300 f maximum temperature; 304 ss jamb seals; and external (out of the airstream) blade-to-blade linkage.
- D. Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval showing damper suitable for pressures to 8 in wg, velocities to 4,000 ft/min and temperatures to 180 f. Testing and ratings to be in accordance with AMCA standard 500.
- E. Damper manufacturer's printed performance data showing standard air leakage less than 6 CFM @ 4 in w.g. shall be submitted for approval. Testing and ratings shall be per AMCA standard 500.

2.5 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ruskin Company.
 2. Potteroff
 3. C&S Air Products
 4. Air Balance Inc.; a division of Mestek, Inc.
 5. Greenheck Fan Corporation.

6. Nailor Industries Inc.
- B. Type: Dynamic Out of Airstream; rated and labeled according to UL 555 by an NRTL.
 - C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
 - D. Fire Rating: 1-1/2 and 3 hours (as required for wall rating).
 - E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
 - F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
 - G. Mounting Orientation: Vertical or horizontal as indicated.
 - H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
 - I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
 - J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
 - K. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F rated.
 - L. Provide an insulated duct access door at every fire damper location.
 - M. Provide an architectural access panel at all locations where access is not provided by others.

2.6 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

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. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

- B. Manufactured Turning Vanes for Metal Ducts: 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. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vaness and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Single and Double wall.
- F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. McGill AirFlow LLC.
 - 4. Nailor Industries Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. 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: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
 - 1. Door and Frame Material: Galvanized sheet steel.
 - 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
 - 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

4. Factory set at 10-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.9 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Flame Gard, Inc.
 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.10 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 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.
- E. 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.
- F. 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. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.

- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.11 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
 4. Temperature Range: Minus 20 to plus 210 deg F.
- B. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 8-inch wg positive or negative.
 2. Maximum Air Velocity: 5000 fpm.
 3. Temperature Range: Minus 20 to plus 250 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- C. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.12 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.

2.13 LOUVERS

- A. Extruded Aluminum Stationary Louver with Horizontal Drainable Blades.
- B. Louvers shall be warranted against manufacturing defects for a period of 5 years.
- C. Louvers shall be licensed to bear the AMCA Certified Ratings label for Water and Air Performance.

- D. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.
- E. Manufacturers
1. All-Lite.
 2. Greenheck Fan Corporation.
- F. EXTERIOR HINGED Typical of All-Lite Model: EFD-637 (L-1 & L-2)
1. Construction:
 - a) Continuous hinge for 6"-deep aluminum louvers in openings up to 100" (2540) wide x 120" (3048) high.
 - b) Hinged louvers will be constructed as a double door.
 - c) Hinged louvers shall include an aluminum channel subframe (door frame) around the perimeter of the opening with an optional 1-1/2" sub-frame flange.
 - d) Hinged louvers will include a flanged frame to prevent the door from over-rotating through the opening.
 - e) Material: Mill Finish 6063-T5 extruded aluminum.
 - f) Frame: 6" deep x 0.081" thick (152 mm x 2 mm) channel. [flanged].
 - g) Blades: 37½° x 0.081" (2 mm) thick Horizontal drainable style.
 - h) Locking device: Steel hasp plate to accommodate field-supplied padlock
 - i) Mounting hardware: Optional aluminum clip angles or Continuous angles
 - j) Factory head and sill flashing with dams
 - k) Screen: ½" x 0.063" (12.7 mm x 1.6 mm) expanded and flattened aluminum birdscreen.
 - l) Mullion: Visible.
 2. Performance Data:
 - a) Based on testing 48 inch x 48 inch (1222 mm x 1222 mm) size unit in accordance with AMCA 500L.
 - b) Free Area: 59.4% nominal
 - c) Free area size: 9.5 ft² (0.88 m²)
 - d) Maximum Recommended Air Flow thru Free Area: 990 fpm (5.03 m/s).
 - e) Air Flow: 9,405 cfm (4.44 m³/s).
 - f) Maximum Pressure Drop: 0.11 in. wg. (27 Pa).
 - g) Water penetration: Maximum of 0.01 ounces per square foot (3.1 g/m²) of free area at an air flow of 990 fpm (5.03 m/s) free area velocity when tested for 15 minutes.
 3. Design Load:
 - a) Wind Load: Louver designs shall withstand the effects of 30 psf (1.44 kPa) of uniform pressure acting inward or outward.
 - b) Seismic Performance: Louvers, including attachments to other construction, shall withstand seismic effects determined by ASCE-7.
 4. Finish louvers after assembly as follows: Finish and custom color selected by Architect.
- G. INTERIOR FIXED Typical of All-Lite Model: EFJ-437 (L-3)
1. Construction:
 - a) 4"-deep aluminum louver.
 - b) Material: Mill Finish 6063-T5 extruded aluminum.
 - c) Frame: 6" deep x 0.081" thick (152 mm x 2 mm) channel, 1-1/2" flanged
 - d) Blades: 37½° x 0.081" (2 mm) thick Horizontal drainable style.
 - e) Screen: Indoor application, no birdscreen.
 - f) Mullion: Visible.

2. Performance Data:
 - a) Based on testing 48 inch x 48 inch (1222 mm x 1222 mm) size unit in accordance with AMCA 500L.
 - b) Free Area: 59.4% nominal
 - c) Free area size: 9.5 ft² (0.88 m²)
 - d) Maximum Recommended Air Flow thru Free Area: 990 fpm (5.03 m/s).
 - e) Air Flow: 9,405 cfm (4.44 m³/s).
 - f) Maximum Pressure Drop: 0.11 in. wg. (27 Pa).
 - g) Water penetration: Maximum of 0.01 ounces per square foot (3.1 g/m²) of free area at an air flow of 990 fpm (5.03 m/s) free area velocity when tested for 15 minutes.
3. Design Load:
 - a) Wind Load: Louver designs shall withstand the effects of 30 psf (1.44 kPa) of uniform pressure acting inward or outward.
 - b) Seismic Performance: Louvers, including attachments to other construction, shall withstand seismic effects determined by ASCE-7.
4. Finish louvers after assembly as follows: Finish and custom color selected by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," 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 dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts regardless of whether shown on the plans or not. 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.
 3. Do not install volume dampers upstream of variable air volume boxes (VAV).
- E. Set all dampers to fully open position during installation, before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. Upstream from duct filters.
 2. At outdoor-air intakes and mixed-air plenums.
 3. At drain pans and seals.
 4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

5. Adjacent to and close enough to fire or smoke dampers, and positioned to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors.
 6. Control devices requiring inspection.
 7. At Air-flow stations for inspection and cleaning of probes.
 8. Elsewhere as indicated.
- I. Access Door Sizes:
1. One-Hand or Inspection Access: 12 by 12 inches.
 2. Two-Hand Access: 16 by 12 inches.
 3. Head and Hand Access: 18 by 12 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 30 by 30 inches.
 6. Body plus Ladder Access: 42 by 30 inches.
- J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- K. Install fire proof, leak-proof access ports on grease duct.
1. Install in accordance with NFPA requirements.
 2. Install on sides of ducts to allow for inspection and cleaning. Do not install on the bottom of duct to avoid grease accumulation.
 3. Install at each change in direction and at maximum 20-foot spacing.
 4. Install upstream from wall or roof penetrations.
- L. Install flexible connectors to connect ducts to equipment.
- M. Do not use flexible duct work on terminal units, in concealed spaces, or to change directions. Maximum length of flexible duct is 6'. Secure at ends with a minimum of 3 screws and tape
- N. Connect diffusers or light troffer boots to ducts with MAXIMUM 60-inch lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands and screws.
- P. Install duct test holes where required for testing and balancing purposes.

3.2 LOUVERS

A. EXAMINATION

1. Examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. Clean Opening thoroughly prior to installation.
2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. INSTALLATION

1. Install louvers at locations as indicated on the drawings and in accordance with manufacturer's instructions.
2. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.
3. Install joint sealants as specified in Section 079000.

D. CLEANING

1. Clean exposed surfaces of louvers with water and mild soap or detergent not harmful to finish taking care to remove fingerprints and soil. Thoroughly rinse surfaces and dry. Do not let soil accumulate during construction period.
2. Touch-up, repair, or replace louvers damaged during installation and construction so that no evidence remains of the corrective work.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement and tight closure.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION

SECTION 23 81 26 - MULTI INDOOR UNIT VARIABLE REFRIGERANT FLOW

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Outdoor heat pumps operating with R-410A refrigerant (CU).
 2. Indoor ducted and ductless air handlers (IDU).
 3. Zone controllers.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, options, and accessories for each unit indicated in accordance with Section 230500.
- B. Shop Drawings:
1. Manufacturer Piping and Diagrams and schematics from manufacturer specific software including specific equipment, pipe sizes, estimated piping lengths, and estimated refrigerant volume.
 2. Performance and capacity details of all units at specified indoor and outdoor conditions.
 3. Refrigerant charge per system including ASHRAE 15 analysis.
 4. 10-year parts only warranty information.
 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Submittal shall include a copy of the installing contractor's certification of heat pump manufacturer approved training.
- D. Operation and maintenance data.
- E. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

1.3 QUALITY ASSURANCE

- A. The system and the design shall be in compliance with ASHRAE 15 Mechanical Refrigerant Code.
- B. Electrical Components, Devices, and Accessories:
1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 2. All wiring shall be in accordance with the National Electric Code (NEC).
 3. The units shall be ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.
- C. All units shall be listed and rated by ANSI/AHRI Standard 1230-2010 and meet all minimum IEER performance requirements as scheduled.

- D. The units shall be ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials and workmanship within **two years** from date of Substantial Completion.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.
 - 2. Warranty Period for Control Boards: Manufacturer's standard, but not less than 3 years from date of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

- 1. All equipment shall be stored and handled according to the manufacturer's recommendation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi Electric
 - 2. Alternate manufacturers shall send approval requests to the CM and AOR 21-days prior to bid day. Include all information relevant to the alternate heat pump system, including but not limited to: unit selections, refrigerant piping layout, refrigerant charge with ASHRAE 15 analysis, branch selector box layout and locations, heating and cooling capacities at design temperatures and including capacity losses from piping lengths, defrost cycles, and combination ratios, dimensional and weight differences, and any other aspect of the system that differs from the system specified.

2.2 SYSTEM DESCRIPTION

- A. Heat Pumps:
 - 1. The system shall be a two-pipe heat pump system. The system is not a simultaneous heating and cooling heat recovery system.

2.3 OUTDOOR UNIT

- A. General: The outdoor unit shall be used specifically with matching manufacturer components. The outdoor units shall be equipped with multiple Simple MA controls that shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 - 1. Both refrigerant lines from the outdoor unit to the indoor unit shall be insulated in accordance with the installation manual.
 - 2. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 - 3. The outdoor unit shall be capable of operating in heating mode down to -13°F ambient temperature, without additional low ambient controls. If an alternate manufacturer is

- selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.
4. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
 5. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 6. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
- B. Unit Cabinet:
1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
- C. Fan:
1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
 2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 3. All fan motors shall be mounted for quiet operation.
 4. All fans shall be provided with a raised guard to prevent contact with moving parts.
 5. The outdoor unit shall have vertical discharge airflow.
- D. Refrigerant
1. R410A refrigerant shall be required for outdoor unit systems.
 2. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
- E. Coil:
1. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction.
 2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 3. The coil shall be protected with an integral metal guard.
 4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
 5. The outdoor coil shall include four circuits with two position valves for each circuit, except for the last stage.
- F. Compressor:
1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non-inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
 2. A crankcase heater(s) shall be factory mounted on the compressor(s).
 3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 15%-5% of rated capacity, depending upon unit size.
 4. The compressor will be equipped with an internal thermal overload.
 5. The compressor shall be mounted to avoid the transmission of vibration.

6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

G. Electrical:

1. The outdoor unit electrical power shall be 208/230, 1-phase, 60 hertz as noted on the plans.
2. The outdoor unit shall be controlled by integral microprocessors.
3. The control circuit between the indoor units, and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.4 CASSETTE-STYLE CEILING-MOUNTED UNITS

A. Manufacturers:

1. Mitsubishi/Trane Co. (The); Worldwide Applied Systems Group.

B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit T-bar ceiling opening of 24 by 48 inches.

C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch thick duct liner.

1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches, with filter.
2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.

E. Refrigeration System:

1. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
2. Refrigerant: R-410A.
3. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
4. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

F. Filters:

1. 1-inch thick, disposable, glass-fiber media, MERV-10 minimum (ASHRAE 52.2) in ceiling cassette units.

G. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature and humidity control modules, humidity contactor, time-delay relay, Heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.

2.5 FILTERS

- A. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with holding frames.
 - 1. Media: Interlaced glass-fibers sprayed with nonflammable adhesive in galvanized-steel frame.
 - 2. Ceiling Cassette Units (Administrative Areas): 1-inch thick, disposable, glass-fiber media, MERV-10 minimum (ASHRAE 52.2).
- B. Washable Panel Filters are not acceptable.
- C. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.6 ACCESSORIES

- A. Wired remote Simple MA control thermostat.
- B. Built-in condensate lift kit (pump).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The heat pump system shall be installed by a contractor with extensive installation and service training. The mandatory contractor service and installation training should be performed by the manufacturer.
- B. Install all equipment with clearance for service and maintenance.

3.2 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Provide factory start-up and set-up of review and adjustment of refrigerant charges/pressures/temperatures, field programmed options, communication with the manufacturer's controller. Verify start-up with a completed commissioning report submitted and approved by the heat pump manufacturer's Service Department
- A. Tests and Inspections:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Heat pump fan coil and outdoor units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. After startup service and performance test change filters.

3.4 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- 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 2 visits to Project during other-than-normal occupancy hours for this purpose.
- D. Perform the following field tests and inspections and prepare test reports:
 1. After installing completely, perform visual and mechanical check of individual components.
 2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Repair or replace malfunctioning units and retest as specified above.

3.5 OWNER TRAINING

- A. The Contractor shall provide 24 hours of Field Supervised and Video Recorded Training and 3 days of off-site Factory Training for 3 CPSED Staff members.

END OF SECTION

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS (Read these DIVISIONS carefully. For purposes of bidding, assume that all work of the DIVISION referenced is to be performed under that DIVISION unless specifically indicated therein to be performed under the ELECTRICAL DIVISION. Coordinate with all divisions to ensure a complete installation)
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - B. Temporary wiring for building construction - see DIVISION 1.
 - C. Cutting and patching - see DIVISION 17
 - D. Allowances – see DIVISION 1.
 - E. Alternatives - see DIVISION 1.
 - F. Excavation and backfilling - see DIVISION 31.
 - G. Concrete - see DIVISION 3.
 - H. Manholes and handholes - see DIVISION 3.
 - I. Magnetic door release - see DIVISION 8.
 - J. Access panels - see DIVISION 8.
 - K. Painting of all backboards (on all sides and edges before mounting); painting of panels (trims and doors - 2 coats before mounting); painting of exposed electrical raceways, boxes and fittings - see DIVISION 9.
 - L. Elevators - see DIVISION 14.
 - M. Sprinkler flow switches and gate valve switches - see DIVISION 21.
 - N. Temperature controls, temperature control wiring, interlock wiring, and boiler control wiring (except as indicated on the electrical drawings) - see DIVISION 23.
- 1.2 SUMMARY
- A. Section Includes:
 - 1. Work that applies to all sections of DIVISION 26.
 - 2. Temporary electrical wiring.
 - 3. Interruption of existing electric service.
 - 4. Concrete bases.
 - 5. Electrical equipment coordination and installation.
 - 6. Sleeves for raceways and cables.
 - 7. Sleeve seals.

8. Grout.
9. Common electrical installation requirements.
10. Removals (demolition) and relocations

1.3 DEFINITIONS

- A. Provide: Furnish and install.
- B. Wiring: Wire, raceways, boxes and fittings.
- C. EPDM: Ethylene-propylene-diene-terpolymer rubber.
- D. NBR: Acrylonitrile-butadiene rubber.

1.4 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. Do all wiring and provide all equipment in accordance with the prevailing issue of the National Electrical Code, State Building Code, State Fire Code, OSHA and any additional local rules or requirements.
- C. Obtain and pay for all necessary permits, certificates, etc. Present satisfactory proof of final inspection and approval by all inspection authorities.
- D. Consider the following Industry Standards as minimum requirements for all materials, equipment and systems where such standards are established for materials in question:
 1. National Board of Fire Underwriters
 2. National Electrical Manufacturers Association
 3. National Fire Protection Association
 4. Institute of Electrical and Electronic Engineers
 5. Local Electric Utility Company
 6. Local Telephone Company
 7. A nationally recognized testing laboratory (UL, ETL, etc.)
 8. Factory Mutual
 9. Americans with Disabilities Act
- E. Where applicable, this installation shall comply with the following NECA (National Electrical Contractors Association) "National Electrical Installation Standards." Except, if there is a conflict between this specification and these standards, the requirements of this specification shall prevail.

1.	NECA 1-2000	Standard Practices for Good Workmanship in Electrical Contracting
2.	NECA 101-2001	Standard for Installing Steel Conduit (Rigid, EMT)
3.	NECA/AA 104-2000	Recommended Practice for Installing Aluminum Building Wire and Cable

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|----|---------------------|--|
| 4. | NECA 400-1998 | Recommended Practice for Installing and Maintaining Switchboards |
| 5. | NECA/EGSA 404-2000 | Recommended Practice for Installing Generator Sets |
| 6. | NECA/IESNA 500-1998 | Recommended Practice for Installing Indoor Commercial Lighting Systems |
| 7. | NECA/IESNA 501-2000 | Recommended Practice for Installing Exterior Lighting Systems |
| 8. | NECA/IESNA 502-1999 | Recommended Practice for Installing Industrial Lighting Systems |

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Services: All shutdowns of services (power, fire alarm, telephone, etc.) must be approved in writing by the Owner. 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 and Owner no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary service.
 3. Do not proceed with interruption of any service without Construction Manager's written permission. All "shutdowns" must be done at other than normal working hours without additional compensation.
 4. Pay all utility charges related to "shutdowns", if any.
 5. All building services (power, fire alarm, telephone, lighting, emergency lighting, exit signs, etc.) must remain in operation during full period of construction. Provide temporary or permanent wiring (if required) to accomplish this.
 6. When an existing fire alarm system is modified or replaced with new, all existing devices must remain in operation until replaced with new devices that are fully tested, approved and operational. All non-functioning equipment shall be so labeled until it is removed or put into service.
- B. Comply with NFPA 70E.

1.6 COORDINATION

- A. 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 and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. 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 08 Section "Access Doors and Frames."
 - D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.
 - E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment that requires positioning before closing in the building.
 - F. Coordinate electrical service connections to components furnished by utility companies.
- 1.7 TEMPORARY ELECTRICAL WIRING: (Extended from existing building)
- A. Provide temporary electrical wiring of power and lighting for construction.
 - B. Extend service from the electrical system of the existing building. However, if it is necessary to disrupt the existing service, provide new temporary service or generator. Do not overtax the service or distribution system. Provide a portable generator, if necessary.
 - C. The Owner to pay the cost of energy consumed.
 - D. The General Contractor to pay for the cost of energy consumed. Provide a three-phase check meter connected to serve all temporary wiring. Meter reading at start and finish of construction shall be recorded in the presence of a representative of the Owner.
 - E. The existing service is 277/480 volts, 3 phase, 4 wire. 120/208 volts is available via step down transformer(s).
 - F. Provide all required connections, panels, circuit breakers, feeders, branch circuit wiring, transformers, lighting fixtures, lamps, receptacles, switches, etc. for a complete and operating temporary electrical system.
 - G. Provide a minimum of 10 footcandles of temporary general illumination throughout the floor area of the building, including all corridors and stairways.
 - H. Existing lighting may be used where it is sufficient and remains energized.
 - I. Provide feeders of sufficient capacity for the requirements of the work, sufficient number of outlets conveniently located so that extension cords not exceeding 100 feet will reach all work requiring artificial light or power.
 - J. All receptacles must be GFCI protected and the entire installation must comply with all applicable OSHA requirements.
 - K. At the end of the day's work, disconnect all lights and power, other than the minimum required security illumination.
 - L. Provide replacement light bulbs and maintenance of the temporary wiring system, as required, throughout the period of construction.
 - M. Conform to all codes and regulations.

- N. Completely remove temporary wiring system upon completion of construction.

1.8 CHANGE ORDERS/PROPOSAL REQUESTS:

- A. During the course of construction, changes in the work may occur. When a significant change is to be made, a Proposal Request will be issued.
- B. Provide a complete cost breakdown when responding to each Proposal Request.
- C. Each item of work to be priced separately.
- D. Each line item to be broken down including quantities and listing separately labor and material.
- E. Both credits and extras shall be separately and clearly quantified.
- F. Allowances for overhead and profit shall be as listed in the supplementary conditions.
- G. If you become aware of a field condition, code requirement, error, or omission that you feel should result in a change to the work, please contact the Engineer for discussion. The Engineer may be able to clarify the situation and avoid unnecessary paperwork.
- H. It is recognized that the Owner benefits when the construction process is a cooperative effort instead of an adversarial relationship. Reasonable give-and-take allows the construction process to move smoothly. Your efforts in this regard will be appreciated by all parties.

1.9 PACKAGED PRICES:

- A. It is in the facility owner's interest, that all bidders receive the best possible quotes on all materials during bidding so that any savings can result in a lower bid price. It is the policy of this Engineer not to specify brands that will result in "packaged" prices. Therefore, manufacturers' representatives are hereby notified that "packaged prices" are prohibited on this project. Upon request, suppliers are to provide bidders with complete material breakdown including each lighting fixture, system, component of system, each piece of equipment, etc. In keeping with this policy, Contractors are hereby cautioned not to anticipate deep discounts after the contract is awarded.

1.10 INSPECTIONS/SITE OBSERVATIONS

- A. The authority having jurisdiction (usually the Municipal Electrical Inspector) shall be notified at periodic intervals that an inspection is requested. Inspections shall be requested at points of progress, meeting the approval of the inspector and as a minimum include the following:
 - 1. Prior to enclosing walls.
 - 2. Prior to enclosing ceilings.
 - 3. Prior to installation of panel/switchgear trims/covers.
 - 4. For observation of connections and grounding at switchboards, transformers and generators.
- B. Do not cover the work before the Engineer has had a chance to observe it in completed form. The electrical foreman shall request a meeting with the Engineer within 10 days after the start of electrical construction to assure that there is agreement on the scope of work and to answer questions.

- C. The electrical foreman shall provide assistance to the Engineer during site observations:
1. Describe the progress of the electrical work in detail.
 2. Accompany the Engineer on his tour of the site, upon request.
 3. Provide use of a suitable ladder, scaffolding or bucket truck to observe the work, upon request.
 4. Remove ceiling tiles, panel trims, junction box covers, etc. for observation of the work, upon request.
 5. Provide use of project drawings, specifications and shop drawings.

1.11 GUARANTEES/WARRANTIES:

- A. See other portions of the Project Manual for details on Guarantees and Warranties. However, minimum shall be one year from date of acceptance by the Engineer.
- B. The Owner reserves the right to make appropriate modifications or extensions of systems and equipment furnished under this contract during the guarantee/warranty period without "voiding" or modifying the guarantee/warranty of equipment and wiring installed under this contract. If manufacturer voids guarantee, it shall not relieve this contractor of his responsibilities for guarantee/warranty period.

1.12 MISCELLANEOUS

- A. Provide all systems complete. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both.
- B. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.
- C. All wiring and connections shall be executed with associated circuit de-energized.

PART 2 - PRODUCTS

2.1 MATERIALS - General:

- A. All materials and equipment shall be new unless specifically stated otherwise.
- B. Materials and equipment shall be suitable for their intended use and for the environment in which they are installed. For example, equipment located outside shall be weatherproof and constructed of materials that will not rust. This includes brackets, screws, etc.
- C. Coordinate all dimensions to make sure that boxes, raceways, equipment, fixtures, etc., fit properly in the finished construction. If special provisions, such as shallow boxes, are required, they shall be provided at no increase in contract price, regardless of catalog numbers listed in contract documents or on shop drawings.
- D. As it is not practical to enumerate in these specifications (or show on the drawings) all details of fittings and accessory equipment required for proper operation of the various electrical systems herein described, it is understood that they will be supplied without extra compensation. Provide

all fittings, terminations, relays, components of panels and equipment, etc., needed for the best performance possible at the present state-of-the-art.

2.2 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- D. 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.
- E. 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.
- F. Right of Way: Give to piping systems installed at a required slope.
- G. Record of Addenda and Change Orders: To avoid overlooking addenda and change order modifications, mark all changes on all copies of drawings and specifications, in a manner acceptable to the Engineer. One method of accomplishing this is to make copies and tape them on the back of the preceding page (tape all edges). Also, circle the changed area and note: see addenda #1, etc. If whole pages or sheets change, either remove the superseded document or put a bold "X" through it.
- H. Record Drawings: Owner's record drawings shall be updated as the project progresses. Maintain documents in a safe, dry location. Indicate clearly and accurately any changes necessitated by field conditions and dimension all raceways built into or under concrete slabs or buried under ground. Contractor to prepare as-built drawings in CAD format at contractor's expense. Contract drawings in CAD format to be furnished to contractor at no cost to contractor. Contractor to provide two compact discs and two hard copies of final as-built drawings.

- I. Operating Instructions and Manuals: Provide the Owner or his representative with complete operating instructions by qualified personnel of all electrical systems. Provide three (3) bound sets (indexed and bound in three sturdy three-ring binders) of operating and maintenance instructions of all electrical systems employed and all shop drawings.
- J. Letter of Confirmation: Include in the above manuals a letter confirming that the following items have been completed. Provide written receipt signed by the Owner or his representative indicating that the first 4 items listed below have been received.
 - 1. The number of circuit breaker locks called for have been provided.
 - 2. Keys have been provided for all locked electrical equipment.
 - 3. The provisions of the "Operating Instructions and Manuals" paragraph of these specifications have been met.
 - 4. Spare fuses have been provided.
 - 5. A TV set matching cable has been provided for each outlet plus spares as called for.
 - 6. The lightning protection system "Master Label" has been provided.
 - 7. A nurse call cord has been provided for each station outlet plus spares as called for.
 - 8. Identification is complete and in accordance with these specifications.
 - 9. As-built electrical drawings have been completed and submitted.
 - 10. All tests are complete and in accordance with these specifications.
 - 11. All required shop drawings have been submitted and approved.
 - 12. The entire installation has been accepted by all authorities.

3.2 SEQUENCE AND BALANCE:

- A. Maintain correct phase sequence of all feeders and circuits by establishing phase identification and maintaining correct relationship throughout the system. Provide line balance within 10% of normal loads.

3.3 LAYOUTS

- A. The electrical system layouts indicated are generally diagrammatic and locations of outlets and equipment are approximate only; govern exact routing of wiring and locations of outlets and equipment by structural conditions and obstructions. This is not to be construed to permit redesigning systems. Interconnect as shown.
- B. Locate all equipment requiring maintenance and operation so that it will be readily accessible. The right is reserved to make any reasonable change in location of outlets and equipment prior to roughing-in without involving additional expense. This may involve slightly longer wiring runs, longer stems, additional mounting provisions, etc. Allow for this in your bid because additional compensation will not be provided. Items not specifically located on the plans shall (for the purposes of bidding) be assumed to be in the farthest, most difficult location. Exact location to be as directed in the field.

3.4 ELECTRICAL SERVICE: (Existing)

- A. Existing electrical service shall remain.

- 1. Service voltage is 277/480 volts, three phase, four wire.

3.5 Conform to all requirements of the local electrical utility company, municipality and state

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable (unless sleeve seal is to be installed), unless seismic criteria require different clearance, or indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry, and with approved joint compound for gypsum board assemblies.
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with firestopping requirements in Division 07.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.7 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07.
- B. Penetrations through exterior surfaces shall be made watertight.
- C. Floor boxes, fed from floor below, shall be fire-rated, poke-through type with UL labeled fire rating to match floor rating.

3.8 WORK INTERFERING WITH EXISTING WIRING:

- A. Make any necessary re-circuiting, extensions of existing circuits and relocations required to properly re-energize remaining existing devices or equipment that may be interfered with by new construction or removals.

3.9 REMOVALS (DEMOLITION) AND RELOCATIONS:

- A. Coordinate with DIVISION 2 section "Selective Demolition."
- B. Do all removal work in a neat and orderly manner so as not to endanger lives nor cause damage. Removal work to include all associated hangers, couplings, supports, raceway and wiring, etc., and shall be complete in every way.
- C. Remove and dispose of, off-site in a legal manner, all raceways and wire indicated to be removed.
- D. Carefully remove and store on-site, where directed by the Owner, all electrical equipment indicated to be REMOVED. After the Owner has examined this equipment, remove and dispose of, off-site in a legal manner, all of this equipment that the Owner does not want. All remaining equipment shall remain the property of the Owner. Relocate the remaining equipment to a permanent storage location on site where directed by the Owner.
- E. The electrical removal (demolition) drawings show the general extent of removals. However it is impractical to show every item; some of which may be concealed. Therefore, assume that you will be required to perform an additional 10% of removal work, without additional compensation. Items not shown to be removed or to remain shall remain or be removed, as directed.
- F. Prior to removing any electrical equipment, properly de-energize all associated wiring. Remove wires from terminals of supply switches or circuit breakers. Properly tape supply and load end conductors of all wiring remaining and not re-used. Properly tag both ends.
- G. Provide outlet boxes, knock-out seals, receptacle cover plates, etc. to leave remaining installation in finished condition.
- H. Take special care in removing equipment indicated to be RELOCATED and properly and thoroughly clean and lubricate this equipment. Renew fuses and overload elements in starters and switches being relocated, if required to properly serve the new installation.
- I. Adjust outlet and junction boxes as required to suit new finished surfaces.

- J. When necessary to perform your work, carefully remove ceiling tiles and properly re-install them. Make sure that hands are clean and take special care to avoid damage. If tiles become damaged, provide new tiles to exactly match existing. If exiting tiles have yellowed with age, it may be necessary to relocate existing undamaged tiles from utility spaces (closets, etc.) and install new tiles in their place.
- K. For relocation of lighting fixtures, see sections entitled "Interior Lighting" and "Exterior Lighting."
- L. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- M. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- N. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- O. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.10 CUTTING AND PATCHING

- A. This trade (specification section) is responsible for its respective cutting and patching.
- B. Do not endanger any work by cutting or altering work or any part of it.
- C. Do not cut or alter work of another Contractor without written consent of the Engineer.
- D. Prior to cutting which affects structural safety of project, or work of another Contractor, submit written notice to the Engineer, requesting consent to proceed with cutting.
- E. Perform all work of fitting, adjustment, cutting, patching, finishing and restoration to perfectly match the quality as specified throughout these specifications. Painting shall match and be feathered into adjacent surfaces.

3.11 CORE DRILLING:

- A. All holes through masonry surfaces must be "core drilled". This trade (specification section) is responsible for its respective core drilling, if any.
- B. Do not endanger any work by drilling or altering work or any part of it.
- C. Do not drill or alter work of another Contractor without written consent of the Engineer.
- D. Prior to drilling which affects structural safety of project, or work of another Contractor, submit written notice to the Engineer, requesting consent to proceed with cutting.
- E. Perform all work of core drilling to perfectly match the quality as specified throughout these specifications.

3.12 ACCESS PANELS:

- A. This trade (specification section) is responsible for determining the number of access panels required for existing and new electrical work (including one under each above ceiling thermodetector) and furnishing them to the mason or drywall contractor for installation. See DIVISION 8.

3.13 CLEANING, PAINTING AND REFINISHING:

- A. Paint all new plywood backboards on all sides and edges before mounting.
- B. Thoroughly clean all new electrical equipment, devices and enclosures upon completion of all work.
- C. Refinish any new electrical equipment whose finish is damaged or rusted, as determined by the Engineer.

END OF SECTION 260500

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600V-COPPER ONLY)

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. Specification Section 260500 Common Work Results For Electrical.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 - 1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
 - 2. Division 26 Section "Undercarpet Electrical Power Cables" for flat cables for undercarpet installations.
 - 3. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability 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.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- 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 NFPA 70.

1.6 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Alcan Products Corporation; Alcan Cable Division.
 2. American Insulated Wire Corp.
 3. General Cable Corporation.
 4. Southwire Company.
 5. Equal approved by Engineer.
- B. All conductors, insulation, and cables shall comply with NEMA WC 70.
- C. Conductor Material: Copper complying with NEMA WC 5 solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- D. Conductor Insulation Types: Type THHN-THWN or XHHW complying with NEMA WC 5.
- E. Multiconductor Cable: Metal-clad cable, Type MC.

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 1. AFC Cable Systems, Inc.
 2. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.
 6. Equal approved by Engineer.
- B. Description: Spring-type factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C. Do not use push-in type wire connectors, use spring type instead.

2.3 SLEEVES AND SLEEVE SEALS: See Specification Section 260500/2.1 & 2.2.

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.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway, Type XHHW, single conductors in raceway, or, Type SE or USE multiconductor cable. See One-Line Diagram.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway, or Mineral-insulated, metal-sheathed cable, Type MI.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- F. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- G. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway, or Mineral-insulated, metal-sheathed cable, Type MI.
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- J. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.

- K. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- M. Fire Alarm Circuits: see FIRE ALARM SECTION.
- N. Health Care Facilities: (For branch circuits concealed in ceilings, walls and partitions); Type THHN-THWN, single conductors in raceway; Metal-clad cable, Type MC; or 90 degree C Type ACTHH cable. Except, do not use Type MC cable in "Patient Care Areas".
- O. Isolated Grounds: Do not use armor of Type MC cable for ground, for Power Quality reasons. Use of MC cable with two (2) insulated ground wires is acceptable.
- P. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- Q. Class 2 Control Circuits: Type THHN-THWN, in raceway, Power-limited cable, concealed in building finishes, or Power-limited tray cable, in cable tray.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. 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. Confirm conduit ID and that conduit will be at or below 40% filled. Confirm jam ratios and take precautions when pulling.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- 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. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- G. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- H. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.
- I. Where the number of current-carrying conductors in a raceway or cable exceeds three, the allowable ampacity shall be reduced per NEC table based on no diversity. Consider neutrals to be current carrying conductors.

3.4 CONNECTIONS

- A. Make all final connections required for a complete and fully operational facility.

- B. Wiring connections to equipment shall include connections to all accessories. For example, if a fan has an associated damper, the wiring must be extended from the fan to the damper at no additional charge. Another example is interconnection of equipment. Some items of equipment consist of several pieces, which must be interconnected before connecting to the circuit. No additional compensation will be paid for interconnections.
- 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 and UL 486B.
- D. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- E. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.
- F. Locations of junction boxes, stub-ups and disconnects are diagrammatic. At the time of design, the exact brand of equipment is usually not known. Therefore, the exact locations of connections are not known. For the purposes of bidding assume the worst, farthest locations. During construction, coordinate connections with final approved shop drawings and coordinate with other trades. Conform to manufacturer's written installation instructions. Provide working space in compliance with code.

3.5 FIELD QUALITY CONTROL

- A. All cables installed under this contract are to be protected from damage prior to installation, during installation, and after installation. Store cable in a dry area protected from physical damage. Before installing cable, raceway shall be clear, dry and free from burrs or sharp edges. When cables pass through metal partitions, provide permanently installed insulating bushings; this applies to all cables installed under this contract (systems, communications, etc.). Insulated bushings are to be installed prior to pulling in of cable. Cables shall be installed back from edge of studs as required by Code.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Perform tests and inspections and prepare test reports.
- D. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance conductors, all feeder conductors, and conductors #8AWG and larger for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Consider the cost and benefit of infrared scanning of cable and conductor splices before retaining subparagraph and associated subparagraphs below.
 - 4. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

- b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare and provide to Owner and Engineer a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E. Test Reports: Prepare and provide to Owner and Engineer a written report to record the following:
- 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- F. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 methods and materials for grounding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Common ground bonding with lightning protection system.

1.3 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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 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. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
- C. 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.
- D. 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.

3.3 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. 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 so vibration is not transmitted to rigidly mounted equipment.

END OF SECTION 260526

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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 the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Division 26 Section "Vibration and Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Metallic slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.7 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.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs. Strength rating to suit structural loading. Comply with MFMA-4, factory-fabricated components for field assembly.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - h. Equal approved by Engineer.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

- a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - e. Equal approved by Engineer.
2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers. As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron with hot-dip galvanized finish..
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 5) Equal approved by Engineer.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

- 5) MKT Fastening, LLC.
 - 6) Equal approved by Engineer.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 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 Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) 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. Support individual horizontal single raceways with separate, malleable-iron pipe hangers or clamps except use spring-steel fasteners for 1-1/2-inch (38-mm) and smaller single raceways above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

- E. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads (+25 percent minimum) within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- F. 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 (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 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 meet seismic-restraint strength and anchorage requirements.
 - 9. Fasteners: Select so load applied to each fastener does not exceed 25 percent of its proof-test load.
- G. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "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 (100 mm) 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 (20.7-MPa, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete (Limited Applications)."
- C. Anchor equipment to concrete base.

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 (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections 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 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.
- J. RGS: Rigid galvanized steel conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways, fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.

- d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
- C. Coordination Drawings: Conduit routing plans, 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. Structural members in the paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
- D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal 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 cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, 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 professional engineer and testing agency.
- F. Source quality-control test reports.
- 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.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 5. Electri-Flex Co.
 - 6. Manhattan/CDT/Cole-Flex.
 - 7. Maverick Tube Corporation.
 - 8. O-Z Gedney; a unit of General Signal.

9. Wheatland Tube Company.
 10. Equal approved by Engineer.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. EMT: ANSI C80.3.
- G. FMC: Zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 2. Fittings for EMT: Steel, set-screw type.
 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.; Pipe & Plastics Group.
 6. Condux International, Inc.
 7. ElecSYS, Inc.
 8. Electri-Flex Co.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT/Cole-Flex.
 11. RACO; a Hubbell Company.
 12. Thomas & Betts Corporation.
 13. Equal approved by Engineer.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

- D. LFNC: UL 1660.
- E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- F. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Arco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products.
 - 5. Equal approved by Engineer.
- B. Description: Comply with UL 2024; flexible type, approved for plenum, riser, or general-use installation, as needed.

2.4 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
 - 4. Equal approved by Engineer.
- C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, 12, or 3R, as indicated or required by environmental conditions.
- D. Fittings and Accessories: Include 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.
- E. Wireway Covers: Hinged type, screw-cover type, or flanged-and-gasketed type, as indicated.
- F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Hoffman.
 - 2. Lamson & Sessions; Carlon Electrical Products.
 - 3. Equal approved by Engineer.
- B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with

captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Fittings and Accessories: Include 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.

2.6 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
 - d. Equal approved by Engineer.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell Company.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet Division.
 - 10. Spring City Electrical Manufacturing Company.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
 - 14. Equal approved by Engineer.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- I. Hinged-Cover Enclosures: 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.
- J. 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.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
 - 1. Color of Frame and Cover: Green.
 - 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, as indicated for each service.
 - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 7. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
 - e. Equal approved by Engineer.

2.9 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section on penetration firestopping.

2.10 SLEEVE SEALS

1. See Section 260500.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Rigid steel conduit.
 2. Concealed Conduit, Aboveground: EMT.
 3. Underground Conduit, over 600 volts: RNC, Type EPC-80-PVC, direct buried.
 4. Underground Conduit, under 600 volts: RNC, Type EPC-40-PVC, direct buried.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): In dry conditions, use FMC. Use LFMC in damp, wet, or dirty conditions.
 6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or 4, as indicated.
 7. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed and Subject to Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Per drawings.

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, wet, or dirty locations.
 5. Damp or Wet Locations: Rigid steel conduit.
 6. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
 7. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
 8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in corrosive locations.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- 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.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits in contact with concrete.
- 3.2 INSTALLATION
- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 12 inches (300 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
1. Run conduit larger than 2-inch (54-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 2. Arrange raceways to cross building expansion joints at right angles; with expansion fittings.

3. Change from Type EPC-40-PVC, to rigid steel conduit before rising above the floor.
- I. 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.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors of all sizes.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
 2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated or heated spaces.
 2. Where otherwise required by NFPA 70.
- N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
 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 the time of installation.

- O. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject.
- P. 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.
- Q. Set metal floor boxes level and flush with finished floor surface.
- R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

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 Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
 - 2. Install backfill as specified in Division 31 Section "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 (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 - 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 - 5. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line; or 40 inches below grade.

- E. 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 the enclosure.
- F. Field-cut openings for conduits 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.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. See Section 260500.

3.6 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Identification for busway and raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- 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. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on a yellow field.
 - 2. Legend: Indicate voltage.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on a yellow field.
 - 2. Legend: Indicate voltage.
- C. Indoor: Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Outdoor: Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.5 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Underground Warning Tape (minimum): Permanent, bright-colored, continuous-printed, vinyl tape compounded for permanent direct-burial service, and with the following features:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side, compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145, Chapter XVII. Colors, legend, and size appropriate to each application.

1. Interior Units: Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
2. Exterior Units: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with 0.0396-inch (1-mm), galvanized-steel backing. 1/4-inch (6-mm) grommets in corners for mounting.

B. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

C. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

3. The above are sample warning labels. Specific warning labels shall be determined by the Electrical Contractor.
4. Electrical Contractor shall provide additional warning signs as required by the local AHJ.
5. Provide additional signage as requested by owner, maintenance and safety personal.

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 1. Engraved legend with white letters on black face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- B. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background, unless otherwise indicated. Minimum letter height shall be 3/8 inch (10 mm).

2.10 CABLE TIES

- A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select 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 INSTALLATION

- A. Verify identity of each item before installing identification products.

- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Busway, Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 30-foot (10-m) maximum intervals.
- B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.
- C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Optional Standby Power.
 - 2. Power.
 - 3. Fire Alarm.
 - 4. Low Voltage.
 - 5. UPS Power.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

- a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White
 - 5) Ground: Green
 - 6) Isolated Ground: Green w/trace ID
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray
 - 5) Ground: Green
 - 6) Isolated Ground: Green w/trace ID
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- F. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive or mechanical fastened warning labels. For outdoor equipment, weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with 0.0396-inch (1-mm), galvanized-steel backing. 1/4-inch (6-mm) grommets in corners for mounting.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. 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.
 - c. Storm switches.
 - d. Generator docking stations.
- L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer, load shedding, kirk key operation.
- N. At each pull box, junction box and outlet box, each circuit contained therein shall be identified by panel designation and circuit number. This shall be accomplished by attaching hand written cardboard labels with string to each set of wires or by other agreed upon methods. In addition, where boxes are concealed, covers shall be marked with the same information using magic marker or other agreed upon means.
- O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, Stenciled legend 4 inches (100 mm) high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Information shall include circuit numbers, type of load served and location of load served. For example: #1 Receptacles in rooms 5 & 6. Panelboard identification shall be engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchboards.
- e. Enclosed switches.
- f. Enclosed circuit breakers.
- g. Enclosed controllers.
- h. Variable-speed controllers.
- i. Push-button stations.
- j. Contactors.

END OF SECTION 260553

SECTION 26 09 37 – ELEVATOR ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes electrical work related to the work of Division 14.

1.2 RELATED DOCUMENTS

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **ELEVATOR ELECTRICAL PROVISIONS** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Wiring and connection diagrams.

1.4 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.

PART 2 - PRODUCTS

2.1 ELEVATOR ELECTRICAL PROVISIONS

- A. A lockable fused disconnect switch or circuit breaker in elevator machine room with 120 volt supply for cab lights.
- B. Light and GFCI convenience outlet in pit with light switch located adjacent to the access door.
- C. Light and GFCI convenience outlet in machine room with light switch located within 18" of lock jamb side of door.
- D. For each elevator, a fused disconnect switch located near the machine room door with wiring to each elevator controller. Provide interlock in disconnect for emergency power lock-out.
- E. A 120 volt, 20 amp, single phase feed to each controller.

- F. A 120 volt circuit for oil heaters (if hydraulic).
- G. J.B. in elevator machine room with 3/4" conduit to telephone backboard for cab telephone.
- H. Three fire alarm control modules for elevator capture and firefighters hat light.
- I. Emergency power is serving the elevator. Provide the following:
 - 1. Automatic transfer of all elevator feeders to the emergency source.
 - 2. Auxiliary normally closed contact (closed when in normal power position/open when in emergency power position) on the automatic transfer switch for elevator emergency control.
 - 3. Auxiliary normally closed contact (open upon initiation of power transfer and to close when transfer is complete) on the automatic transfer switch for elevator emergency control.
 - 4. Automatic transfer switch shall have an inhibit function which will delay transfer to normal and/or emergency power by an adjustable period of 0-300 seconds.
 - 5. Automatic transfer switch shall have a phase monitor feature, which prohibits the transfer of power between "live" sources unless the sources are in phase with each other.
 - 6. If the sprinkler shaft is sprinklered due to combustible shaft construction, provide shunt trip accessories to the circuit breaker serving the elevator control panel. Also provide additional auxiliary normally closed contact on the automatic transfer switch for elevator emergency control.
 - 7. Provide 2#12+1#12G wires in 3/4" conduit from the automatic transfer switch to each of the elevator controllers in the elevator machine room (to prevent all but one elevator from running at once).
 - 8. For each set of contacts indicated above provide 2#12+1#12G wires in 3/4" conduit from the automatic transfer switch to each of the elevator controllers in the elevator machine room.
 - 9. The requirements above may vary and is dependent on specific elevator vendor requirements for the project specific installation. The electrical contractor shall coordinate with the elevator vendor and provide all necessary automatic transfer switch features and wiring and conduit between elevator controller(s) and the associated automatic transfer switch serving them.
 - 10. If the elevator produces elevator regenerative power and is not also wired to other emergency loads to absorb the regenerative power, then provide a regenerative resistor to absorb the elevator created regenerative power to prevent motoring of the emergency generator.
- J. If the selector switch is not located on the hoistway wall, provide four #14 wires in 1/2" conduit to the elevator machine room (where elevators are located in separated areas.)
- K. When the elevator controllers are not located in the common machine room, provide the following:
 - 1. Eight #14 wires in 3/4" conduit between elevator controllers.
- L. For high-rise buildings, provide a 2-inch raceway between elevator controller and Elevator Fire Station Panel (located at the fire control center).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide wiring according to Division 26, Section "Conductors and Cables".
- B. Provide raceways according to Division 26, Section "Raceways and Boxes".
- C. Provide grounding according to Division 26, Section "Grounding Bonding & Surge Protection Devices".
- D. Comply with requirements of elevator vendor and elevator inspector.

END OF SECTION 260937

SECTION 26 24 20 – MECHANICAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Electrical work relating to the work of Division 22 “PLUMBING” and Division 23 “MECHANICAL”.

1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all PLUMBING AND MECHANICAL ELECTRICAL REQUIREMENTS work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Wiring and connection diagrams.

1.4 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufactures listed.

2.2 HVAC & PLUMBING

- A. Provide all wire, conduit, boxes and fittings for all HVAC and plumbing equipment and final connections. Conform to Division 26, Section “Conductors and Cables”.
- B. Examine DIVISION 22 and 23 carefully for any work specified as performed under this Section and coordinate.
- C. Provide all disconnects according to Division 26, Section “Enclosed Switches and Circuit Breakers”.

- D. Provide nameplates on all disconnects according to Division 26, Section "Basic Materials and Methods".
- E. Automatic starters and manual starters (thermal toggle switches) that are to be furnished under DIVISION 22 and 23 are assumed to be shipped loose, install and wire (both sides) under this Section. Some starters may be variable frequency drive (VFD) type and may have built-in disconnects. Provide wiring on both sides. Some VFD's are large and heavy. Provide adequate mounting support and proper working space.
- F. Provide a manual starter (thermal toggle switch) at each single phase motor not furnished with an automatic starter. Manual starters to consist of a manual operated toggle switch equipped with a melting alloy type thermal overload relay. Starters must be inoperative if thermal unit is removed. Mount at motor location.
- G. Provide an automatic magnetic starter for each three phase motor not furnished with an automatic starter as required to suit the load and control strategy.
- H. Temperature controls are provided under DIVISION 23. Temperature control wiring, interlock wiring, and boiler control wiring are provided under DIVISION 23, except as shown on the electrical drawings or indicated differently herein.
- I. Install and wire to electric heating units furnished under DIVISION 23.
- J. Provide power wiring to all control transformers and temperature control panels.
- K. Control valves and transformers for all heating units are furnished and installed under DIVISION 23.
- L. Do not use electrical drawings for location of feeds to mechanical equipment. In general, use mechanical drawings for bidding purposes and final approved mechanical shop drawings for actual installation. However, report any discrepancies to mechanical and electrical engineer for final determination, prior to installation.
- M. Wire all miscellaneous circulation and condensate pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install according to NEMA standards.
- B. Mount plumb and rigid without distortion of box.
- C. Provide supports and nameplates, according to Division 26 section "Basic Electrical Materials and Methods".
- D. Ground according to Division 26, Section "Grounding, Bonding & Surge Protective Devices".
- E. Provide wiring according to Division 26, Section "Conductors and Cables".
- F. Provide raceways according to Division 26, Section "Raceways and Boxes".

END OF SECTION 262419

SECTION 26 27 26 - WIRING DEVICES

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 the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Snap switches and wall-box dimmers.
 - 3. Wall-switch sensors.
 - 4. Cord and plug sets.
 - 5. Device trim plates.
 - 6. Emergency lighting relays.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: Include all manufacturers' packing label warnings and instruction manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

- 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 NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
- B. Provide additional receptacles to suit the particular equipment served.
- C. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wiring Devices:
 - a. General Electric Company
 - b. Bryant Electric, Inc./Hubbell Subsidiary.
 - c. Hubbell Incorporated; Wiring Device-Kellems.
 - d. Leviton Mfg. Company Inc.
 - e. Pass & Seymour/Legrand; Wiring Devices Div.
 - f. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper)
 - 2. Multioutlet Assemblies:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Wiremold Company (The).
 - c. Equal approved by Engineer.

2.2 RECEPTACLES

- A. General
 - 1. Comply with NEMA WD 1, NEMA WD 6, and UL 498.
 - 2. Provide additional receptacles to suit the particular equipment served.
 - 3. Provide other special duty receptacles as indicated on the drawings.
 - 4. Receptacles mounted outdoors or in other wet or damp locations shall be GFI type and installed in weatherproof enclosures, the integrity of which is not affected when the receptacle is in use (attachment plug cap inserted). Also comply with UL 943, Class A, and include indicator light that is lighted when device is tripped.
 - 5. Color as selected by Architect, or as noted.
 - 6. Catalog numbers are for General Electric Company, or as noted.
 - 7. Isolated-Ground, Duplex Convenience Receptacles: Straight blade; equipment grounding contacts shall be connected only to the 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.
- B. Provide 20 amp. commercial specification grade, grounded, DUPLEX RECEPTACLES.

20A/125V	Duplex Receptacle	GE #GCR-20
20A/125V	Single Receptacle	GE #4102
30A/125V/250V	4 Wire Receptacle	GE #1439-3
50A/125V/250V	4 Wire Receptacle	GE #4181-3
20A/125V	Duplex Receptacle	GE #5362-IG (Isolated Ground)
20A/125V	Single Receptacle	GE #4102-IG (Isolated Ground)
20A/125V	GFI Dup. Rec.	GE #GFR 5342

- C. Provide Wiring Devices for HAZARDOUS (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
- D. Provide CORD AND PLUG SETS
- Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.3 SWITCHES

A. GENERAL

- Comply with NEMA WD 1 and UL 20.

- B. Provide 20 amp., toggle type, "Federal Specification Grade" lighting switches.

Single pole	GE #5951	Three-way	GE #5953
Double pole	GE #5952	Four-way	GE #5954

- C. Provide heavy duty, specification grade, 20 amp., quiet "AC", "DECORA" TOUCH SWITCHES. Catalog numbers are for Slater Medalist Decora Series.

Single pole	2770	Three-way	2773
Double pole	2772	Four-way	2774

- D. Provide Pilot Light Switches, 20 A, single pole, with neon-lighted handle, illuminated when switch is "ON."
- E. Provide Key-Operated Switches, 120/277 V, 20 A, Single pole, with factory-supplied key in lieu of switch handle.
- F. Provide Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
- G. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters, unless otherwise indicated on the drawings.
- Control: Continuously adjustable combination slider and toggle switch with single-pole or three-way switching to suit connections. Comply with UL 1472.

- H. Occupancy Sensors

1. As indicated on the drawings.
- I. Wall-Switch Sensors:
 1. As indicated on the drawings.
 - J. Emergency Lighting Relays
 1. Provide relays in emergency lighting circuits to cause emergency lights to automatically light whenever the emergency transfer switch goes to the emergency position, regardless of the position of the local switch.
 2. Provide SPDT transfer relays in NEMA #1 enclosure above accessible suspended ceiling or flush mounted adjacent to lighting panel. Provide one relay for each switch. Provide holding coils rated for continuous operation with 120 ampere contacts. Wire as indicated on the drawings or as directed
- 2.4 WALL PLATES
- A. Single and combination types to match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
 3. Material for Unfinished Spaces: Galvanized steel.
 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
 - B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, polycarbonate with lockable cover.
 - C. Single and combination types to match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Provide smooth (unribbed) high-impact thermoplastic switch and receptacle cover plates. Color as selected by Architect.
 3. Receptacles mounted outdoors or in other wet or damp locations shall be installed in weatherproof enclosures with key lock cover, the integrity of which is not affected when the receptacle is in use (attachment plug cap inserted).
- 2.5 MULTIOUTLET ASSEMBLIES
- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Wiremold Company (The).
 3. Panduit Corp.
 4. Equal approved by Engineer.
 - B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
 - C. Raceway Material: Metal, with manufacturer's standard finish.

2.6 SERVICE POLES

- A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices, connections, or outlets in pole near floor.
1. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 3. Finishes: Manufacturer's standard painted finish and trim combination.
 4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
 5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
 6. Voice and Data Communication Outlets: Provide type as indicated on the drawings or as directed.

2.7 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device 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 just 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 meet provisions of 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. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they 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 (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the 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.
10. Install devices and assemblies level, plumb, and square with building lines.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. 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. Remove wall plates and protect devices and assemblies during painting.

G. 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.
4. Install wall dimmers to achieve indicated rating after derating for ganging.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings. Obtain approval of adjustments from Architect/Engineer prior to installation.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and

durable wire markers or tags inside outlet boxes. Brother P-Touch Labeling System is acceptable, in lieu of engraving.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 3 percent or higher is not acceptable.
 - 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. The tests shall be diagnostic, indicating proper polarity, 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.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

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. Cartridge fuses rated 600-V AC and less for use in control circuits, enclosed switches, switchboards, enclosed controllers, and motor-control centers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components. Include the following for each fuse type indicated:

- 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
- 3. Current-limitation curves for fuses with current-limiting characteristics.
- 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
- 5. Coordination charts and tables and related data.
- 6. Fuse sizes for elevator feeders and elevator disconnect switches.

- B. Operation and Maintenance Data: 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. Ambient temperature adjustment information.
- 2. Current-limitation curves for fuses with current-limiting characteristics.
- 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
- 4. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single source from a single manufacturer to the extent possible.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.

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 the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.
 - 5. Gould
 - 6. Equal approved by Engineer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages, at class and current rating indicated.

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 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: Class L, time delay.
 - 2. Feeders: Class J, time delay.
 - 3. Motor Branch Circuits: Class RK5, time delay.
 - 4. Other Branch Circuits: Class RK1, time delay.
 - 5. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Molded-case switches.
 - 5. Electronic trip circuit breakers.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to Section 260548.
 - 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."

1.5 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.
- E. 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.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For enclosed switches and circuit breakers 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. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 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. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. 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.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application.
- E. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electric Service: Per Section 260500.

1.8 COORDINATION

- 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.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type GD, General Duty: not allowed.
- C. Type HD, Heavy Duty, Single Throw, 240 or 600-V AC, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V AC, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Double Throw, 240 or 600-V AC, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. Fusible switches, 800 amps and above: NEMA bolted pressure contact switches made by firmly bolting the switchblades to the stationary contact terminals and to the hinge terminals and meet UL 977.
- G. 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, capable of being grounded and bonded; 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. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
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.
9. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac or 120-V ac as required by the specific control system.

- H. All fusible switches: shall be rated for the application voltage specified and have a UL listed short circuit rating to match the fuse installed.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

- B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- C. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- D. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- E. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- F. 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, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

7. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac or 120-V ac as required by the specific control system.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 1. General Electric Company; GE Consumer & Industrial - Electrical Distribution – to match the base building standard.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current 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.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Where indicated or required, 100% rated, with RMS sensing, field-replaceable rating plug, trip indication (showing which adjustment caused trip), with interrupting capacity to meet available fault current, and with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I²t response.
 5. Arc Energy Reduction via Energy-reducing maintenance switching with local status indicator for circuit breakers with 1200A frame or above.
 6. Settings shall be per the power system studies provided by the electrical contractor.
 7. Arc Flash Reduction:
 - a. Breakers where the highest continuous trip setting can be 1200 amps and above shall utilize Arc Flash Reduction Maintenance Technology. The unit shall have a dedicated operation mechanism and visual indication that the reduction technology is operating. The technology shall reduce the trip unit Instantaneous pickup value when activated. The device shall not comprise breaker phase protection when enabled. Once the unit is disabled, the recalibration of trip unit phase protection shall not be required. Activation and deactivation of the technology trip setting shall be accomplished without opening the circuit breaker door and exposing operators to energized parts.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

- J. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
- K. Switching Duty: All single pole circuit breakers shall be rated SWD.
- L. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits; Type HACR for heating, air-conditioning, and refrigerating equipment..
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - 7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 8. Alarm Switch: One NO or NC contact that operates only when switch has tripped. Coordinate with alarm system for exact configuration.
 - 9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 10. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - 11. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
 - 12. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.4 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
7. Alarm Switch: One NO or NC contact that operates only when switch has tripped. Coordinate with alarm system for exact configuration.
8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac or 120-V ac as required by the specific control system.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncrosive Liquids: NEMA 250, Type 12.
 6. Indoor Hazardous Areas Indicated on Drawings, Class 1, Division 1: NEMA 250, Type 7.
 7. Indoor/Outdoor Hazardous Areas Indicated on Drawings, Class 1, Division 1: NEMA 250, Type 8.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with 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 individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and 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 fusible devices.
- F. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

- G. Most manufactures of bolted pressure switches make for line entering top and load exiting bottom. Verify shop drawings before running conduits.
- H. Do not mount switches or circuit breakers upside down or side ways.
- I. Aluminum Cable Connections: If aluminum wire is permitted, section "Conductors and Cables", circumferential compression type lugs are required for all terminations on aluminum wire. Where screw type lugs are used, it will be necessary to convert from aluminum to copper wiring before connection. This can be done by use of T & B or IlSCO, compression connectors. Adequate wiring space must be provided for connectors, if used.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "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. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Inspect mechanical and electrical connections.
 - 4. Verify switch and relay type and labeling verification.
 - 5. Verify rating of installed fuses.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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.
- C. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. 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 as specified in Division 26 Section "Power System Studies".
- C. Thermal-magnetic circuit breakers:
 - 1. Test circuit and correct deficiencies
 - 2. Set magnetic trip at minimum.
 - 3. Turn associated loads "on".
 - 4. Turn breaker on/off a minimum of six (6) times.

5. If nuisance tripping occurs, set "up" one notch and repeat test.
6. Repeat steps 4 and 5 until nuisance tripping no longer occurs.

D. Electronic trip-unit circuit breakers:

1. Test circuit and correct deficiencies.
2. Set "long time pickup" at 1.0 (Do not change)
3. Set other adjustments at minimum.
4. Turn associated loads "on".
5. Turn breaker on/off a minimum of six (6) times.
6. If nuisance tripping occurs, adjust setting that caused trip "up" one notch and repeat test.
7. Repeat steps 5 and 6 until nuisance tripping no longer occurs.

END OF SECTION 262816

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures with LED sources.
2. Lighting fixtures mounted on exterior building surfaces with LED sources.
3. Accessories, plaster rings, fasteners, etc.

1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all INTERIOR LIGHTING work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

1.3 SUBMITTALS

- A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. Operation and maintenance data.

1.4 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 LIGHTING LUMINAIRES

- A. See schedules on drawings.
- B. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The

technical requirements that the luminaire shall meet for each Application Category as currently defined by the DLC Premium qualification requirements at the time of bid.

- C. Color Temperature of 3000K-3500K for interior luminaires as listed in the Luminaire Schedule on the plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).
- D. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 5-step MacAdam Ellipse binning process.
- E. Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- F. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- G. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
- H. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- I. Driver shall have a rated life of 50,000 hours, minimum.
- J. Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- K. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
- L. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
- M. LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
- N. LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
- O. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- P. Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
- Q. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
- R. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- S. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
- T. The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
- U. Provide all of the following data on submittals:

1. Delivered lumens
2. Input watts
3. Efficacy
4. Color rendering index.

- V. The failure of one LED shall not affect the operation of the remaining LEDs.
- W. Emergency Inverters shall be sine-wave type, or have written confirmation from the luminaire manufacturer that the luminaire will function with a square-wave inverter.
- X. LED driver shall be compatible with dimming controls where dimming is indicated on the plans. Dimmable drivers shall use Dimming Constant Current (DCC) or Pulse Width Modulation (PWM) operation.
- Y. LED luminaires shall dim to (20%, 15%, 10%, 5%, or 0.1%) as specified in the Luminaire Schedule on the plans without visible flicker or "popcorn effect". "Popcorn effect" is defined as the luminaire being on a pre-set dimmed level (less than 100%), and going to 100% prior to returning to the pre-set level when power is returned to the luminaire.

2.3 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture).
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage 2.68 mm.
- D. Wires For *Humid Spaces*: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
1. Install a minimum of four ceiling support system wires for each fixture. Locate not more than 6 inches (150 mm) from fixture corners.
 2. 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 (20-mm) metal channels spanning and secured to ceiling tees.
 3. Provide additional support, independent of ceiling grid for all fixtures (including incandescent) by use of jack chain having breaking strength of 3 times the weight of the fixture (minimum of #12). Fixtures over one foot in length shall be supported at all four corners.
 4. See section 260548, "Seismic Controls" for additional requirements.
- C. Suspended Fixture Support: As follows:
1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 3. Continuous Rows (cable mounted): Suspend from cable.

4. Support: Per NEC 410-16.
- D. Adjust aimable fixtures to provide required light intensities. Adjust all fixtures to the satisfaction of the Engineer. Adjustments required at night shall be done at no additional charge. Provide all equipment needed including scaffolding, if required.

END OF SECTION

SECTION 26 52 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Exterior luminaires and accessories
- B. Grounding
- C. Conduit and wiring

1.2 QUALITY ASSURANCE

- A. Comply with the following codes and standards:
 - 1. *National Electrical Code* (NEC) for components and installation.
 - 2. International Building Code
 - 3. ASCE-7, Minimum Design Loads for Buildings and Other Structures
 - 4. The national Energy Policy Act and Energy Star requirements for lighting products.
- B. Provide luminaires listed and labeled by a nationally recognized testing laboratory (NRTL) for the application, installation condition, and the environments in which installed.
- C. Use manufacturers that are experienced in manufacturing luminaires, lamps and ballasts similar to those indicated for this Project and have a record of successful in-service performance.

1.3 DEFINITIONS

- A. Unless otherwise specified or indicated, terms used in this Section are as defined in the National Electrical Code or the IESNA Lighting Handbook.

1.4 SUBMITTALS

- A. Submit the following in accordance with Project submittal procedures.
 - 1. **Catalog Data:** Submit catalog data describing luminaires, lamps, ballasts, and luminaire finishes. Include data substantiating that materials comply with specified requirements. Arrange data for luminaires in the order of luminaire designation.
 - 2. **Performance Curves/Data:** Submit certified photometric data for each type of luminaire.
 - 3. **Shop Drawings:** Submit manufacturer's drawings for non-standard luminaires.

4. Maintenance Data: Submit maintenance instructions for inclusion in the operations and maintenance manuals.

1.5 EXTRA MATERIALS

- A. Furnish the following extra materials matching products installed. Package with protective covering for storage and identify with labels describing contents.
 1. LED Luminaires: 10 percent of quantity of LED luminaires of each type, but no fewer than two of each type.
 2. Drivers: 10 percent of quantity of ballasts of each type, but not less than one of each type.
 3. Lenses, Diffusers, Covers, Globes, and Guards: 10 percent of quantity of each type, but not less than one of each type.

1.6 RECEIVING, STORING AND PROTECTING

- A. Receive, inspect, handle, and store products according to the manufacturer's written instructions and NECA/IESNA 501, *Recommended Practice for Installing Exterior Lighting Systems*.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Alternate products may be accepted; follow Section 01 2500 *Substitution Procedures*.

2.2 FINISHES

- A. Furnish luminaires and accessories with finishes as scheduled that are resistant to fading, chalking, and other changes due to aging and exposure to heat and ultraviolet light. Acceptable finishes for metals are:
 1. Hot-dipped galvanized steel: ASTM A 123/A 123M.
 2. Brushed natural aluminum
 3. Anodized aluminum: AAMA 611, *Anodized Architectural Aluminum, Class I*.
 4. Powder coated aluminum: Fluorocarbon polymer powder coating per AAMA 2605, *Superior Performing Organic Coatings* over chrome phosphate conversion coated aluminum.
- B. Reject luminaires and accessories with finish having runs, streaks, stains, holidays and defects.
- C. Replace luminaires and accessories showing evidence of yellowing, fading, chalking, and other changes indicating failure during warranty period.
- D. Use stainless steel for exposed hardware.

2.3 EXTERIOR LUMINAIRES - GENERAL

- A. Furnish exterior luminaires that comply with requirements specified in this Section and in the luminaire schedule on the Drawings.
- B. Luminaires shall be NRTL-listed as conforming to UL 1598 - *Luminaires*.
- C. Luminaire photometric characteristics shall be based on IESNA approved methods for photometric measurements performed by a recognized photometric laboratory.
- D. Luminaire housing shall be primarily metal.
 - 1. Metal parts shall be free from burrs and sharp corners and edges.
 - 2. Sheet metal components shall be fabricated from corrosion-resistant aluminum, formed and supported to prevent sagging and warping.
 - 3. Exposed fasteners shall be stainless steel.
- E. Doors and frames shall be smooth operating and free from light leakage under operating conditions.
 - 1. Relamping shall be possible without the use of special tools.
 - 2. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
 - 3. Door shall be removable for cleaning or replacing lens.
- F. Luminaires shall have minimum reflecting surface reflectance as follows unless scheduled otherwise:
 - 1. White surfaces: 85 percent
 - 2. Specular surfaces: 83 percent
 - 3. Diffusing specular surfaces: 75 percent
- G. Provide lenses, diffusers, covers and globes as scheduled on the Drawings fabricated from materials that are UV stabilized to be resistant to yellowing and other changes due to aging or exposure to heat and ultraviolet radiation.
- H. Doors shall have resilient gaskets that are heat-resistant and aging-resistant to seal and cushion lens and refractor.

2.4 LED LUMINAIRES

- A. LED luminaires shall conform to UL 1598 and to UL 8250 – *Safety Standard for Light-Emitting Diode (LED) Light Sources for Use in Lighting Products*.
- B. Products shall be lead and mercury free.
- C. Photometric characteristics shall be established using IESNA LM-79-08, *IESNA Approved Method for the Electrical and Photometric Measurement of Solid-State Lighting Products*.

- D. Ingress protection for optical assembly shall be IP65 or better in accordance with ANSI/IEC 60529 - *Degrees of Protection Provided by Enclosures*.
- E. Color characteristics of LED luminaires shall be as follows in accordance with ANSI C78.377 – *Specifications for the Chromaticity of Solid State Lighting Products*.
- F. LED and driver cooling system shall be passive and shall resist the buildup of debris.
- G. LED luminaire output after 50,000 hours of operation shall be not less than 70 percent of the initial lumen output when determined in accordance with IESNA LM-80-08 – *IESNA approved Method for Measuring Lumen Maintenance of LED Lighting Sources*.
- H. LED luminaire electrical characteristics:
 - 1. Supply voltage: 120 V, 208 V, 240 V, 277 V, or 480 V as indicated on the Drawings. Provide step-down transformers if required to match driver input voltage rating.
 - 2. Total harmonic distortion (current): Not more than 10 percent
 - 3. Power factor: Not less than 90%
 - 4. RF interference: Meet FCC 47 CFR Part 15/18
 - 5. Transient protection: IEEE C62.41 Class A.
- I. Warranty:
 - 1. Manufacturer shall replace any luminaires that fail to operate properly within 60 months of the date of acceptance of the installation. Lens yellowing or hazing will be considered a failure.
 - 2. Manufacturer shall replace any luminaires that experience housing or finish failure within 5 years of the date of acceptance of the installation.
- J. Manufacturers: Subject to compliance with requirements, provide products as scheduled or specified on the Drawings.

PART 3- EXECUTION

3.1 EXAMINATION

- A. Examine areas, spaces, and surfaces to receive exterior luminaire (s) for compliance with installation tolerances and other conditions affecting performance of the product. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions, NECA/IESNA 501, and approved shop drawings.
- B. Locations of luminaires shown on the Drawings are diagrammatic. Coordinate luminaire locations with building finishes, building structure, paving and striping, utility piping, security fences, and existing trees.
- C. Set luminaires plumb, square, level and secure.
- D. Install surface mounted luminaires directly to an outlet box which is supported from structure.

- E. Install lamps in luminaires in accordance with manufacturer's instructions.

3.3 CONCRETE FOUNDATIONS

- A. Construct concrete foundations with exterior 4000 psi concrete and reinforcing conforming to Section 03 3001, *Reinforced Concrete*.
- B. Comply with details on the Drawings and manufacturer's recommendations for foundation dimensions, reinforcing, anchor bolts, nuts and washers.

3.4 GROUNDING

- A. Install grounding for exterior lighting using materials and methods specified in Section 26 0526, *Grounding and Bonding for Electrical Systems*.

3.5 LIGHTING CONTROL SYSTEM

- A. Install exterior lighting control system components in accordance with the manufacturers' instructions. Have installation instructions available at the construction site.
- B. Provide separate control of exterior lighting system as follows:
 - 1. Pedestrian walkway, and roadway lighting: "ON" at dusk, "OFF" at dawn.

3.6 FUSES AND FUSE HOLDERS.

- A. Install fuse(s) and fuse holders in hand hole or transformer base for each luminaire.
 - 1. Install fuse holder and fuse in each phase conductor.
 - 2. Install fuse holder with permanently mounted dummy fuse in neutral conductor.
- B. Install insulator boots over fuse holders and tape wrap where conductor enters boot.

3.7 RACEWAYS AND BOXES

- A. Install conduit system for exterior lighting using materials and methods specified in Section 26 0533, *Raceways and Boxes for Electrical Systems*.

3.8 BUILDING WIRE

- A. Install wiring for exterior lighting using materials and methods specified in Section 26 0519, *Low Voltage Electrical Power Conductors and Cables*.

3.9 FIELD QUALITY CONTROL

- A. Inspect each installed lighting unit for damage. Replace damaged luminaires, and components.
- B. Test installed luminaires for proper operation.
 - 1. Provide instruments to make and record test results.

2. Replace or repair malfunctioning luminaires and components then re-test.
3. Repeat procedure until all luminaires operate properly.

C. Replace inoperative lamps.

3.10 ADJUSTING AND CLEANING

- A. Clean each luminaire inside and out, including plastics and glassware. Use methods and materials recommended by manufacturer.

END OF SECTION 26 52 00

SECTION 28 31 11 - ADDRESSABLE FIRE ALARM SYSTEM (EXTENSION OF EXISTING)

PART 1.0 - GENERAL

1.1 DESCRIPTION:

- A. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment to be connected to this buildings existing addressable fire alarm system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, auxiliary control devices, and wiring as shown on the drawings and specified herein.
- B. The fire alarm system extension shall comply with requirements of NFPA Standard No. 72 for Local Protected Premises Signaling Systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.
 - 1. All new fire alarm devices shall be compatible and of the same manufacturer as the existing EST, E3 series control panel.
- C. The FACP and peripheral devices shall be manufactured 100% by E.S.T.
- D. Underwriters Laboratories Inc. (UL) - USA:
 - UL 38 Manually Actuated Signaling Boxes
 - UL 268 Smoke Detectors for Fire Protective Signaling Systems
 - UL 521 Heat Detectors for Fire Protective Signaling Systems
 - UL 864 Standard for Control Units for Fire Protective Signaling Systems
 - UL 1481 Power Supplies for Fire Protective Signaling Systems
 - UL 1638 Visual Signaling Appliances
 - UL 2017 General-Purpose Signaling Devices and System
- E. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final check-out and to ensure the systems integrity.

1.2 SCOPE:

- A. Extension of existing EST E3 Fire Alarm system.
- B. Basic Performance:
 - 1. Initiation Device Circuits (IDC) shall be wired NFPA Style Z (Class A) as part of an addressable device connected by the SLC Circuit.
 - 2. When not wired directly from panel NAC circuits, Notification Appliance Circuits (NAC) shall be wired NFPA Style Z (Class A) as part of an addressable device connected by the SLC Circuit.
 - 3. All circuits shall be power-limited, per UL864 requirements.
 - 4. A single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

C. BASIC SYSTEM FUNCTIONAL OPERATION

When a fire alarm condition is detected and reported by one of the system initiating devices, the following elevator control functions shall immediately occur:

1. The elevator cabs shall travel to the first floor and the doors shall open.
2. If the first floor lobby smoke detector is in the alarm, the elevator cabs will travel to a pre-determine alternate floor and the doors shall open.
3. If the smoke detector in the elevator machine room or the heat detector located at the top of the shafts goes into alarm, the firemen hat shall illuminate notifying the fireman not to use the elevators.

1.3 SUBMITTALS

A. General:

1. An electronic copy of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment, if the minimum standards are met.
3. For equipment, other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

C. Software Modifications

1. Provide the services of a qualified technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
3. Provide firmware updates through USB thumb drive.

1.4 GUARANTY:

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period, shall be included in the submittal bid.

1.5 MAINTENANCE:

- A. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all

post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

1.6 APPLICABLE STANDARDS AND SPECIFICATIONS:

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

A. National Fire Protection Association (NFPA) - USA:

No. 13 Sprinkler Systems
No. 70 National Electric Code (NEC)
No. 72 National Fire Alarm Code
No. 101 Life Safety Code

B. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

C. Local and State Building Codes.

D. All requirements of the Authority Having Jurisdiction (AHJ).

1.8 APPROVALS:

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc (Ninth Edition)
FM Factory Mutual
CAN/ULC - S527-99 Standard for Control Units for Fire Alarm Systems

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a fire protective signaling system, meeting the National Fire Alarm Code.

B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

D. All equipment must be available "over the counter" through the Security Equipment Distributor (SED) market and can be installed by dealerships independent of the manufacturer.

2.2 CONDUIT AND WIRE:

A. Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
4. With the exception of telephone connections, wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch (19.1 mm) minimum.
7. Where fire alarm circuiting is run concealed above ceilings or fished in walls, U.L. listed fire alarm type "MC" cable can be use.
8. The supply and return loops shall be separated 5 feet horizontally and two feet vertically.

B. Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NEC 760 (e.g., FPLR).
5. Wiring used for the multiplex communication circuit (SLC) shall be twisted non-shielded and support a minimum wiring distance of 10,000 feet when sized at 12 AWG.
6. All field wiring shall be electrically supervised for open circuit and ground fault.

- C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

2.3 SYSTEM COMPONENTS:

A. Addressable Pull Box (manual station)

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual pull stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

B. Intelligent Multi-Sensing Detector

1. The intelligent detector shall be an addressable device which is capable of detecting multiple threats by employing photoelectric and thermal technologies in a single unit. This detector shall utilize advanced electronics which react to slow smoldering fires (photoelectric) and heat (thermal) all within a single sensing device.
2. The multi-detector shall include two LEDs for 360-degree viewing.
3. Automatically adjusts sensitivity levels without the need for operator intervention or programming. Sensitivity increases with heat.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
2. The detectors shall be ceiling-mounted and available in an alternate model with an integral fixed 135-degree heat-sensing element.
3. Each detector shall contain a remote LED output and a built-in test switch.
4. Detector shall be provided on a twist-lock base.
5. It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
6. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall periodically flash to indicate that the detector is in communication with the control panel.
7. The detector shall not go into alarm when exposed to air velocities of up to 1500 feet per minute (fpm).
8. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
9. All field wire connections shall be made to the base through the use of a clamping plate and screw.

D. Intelligent Thermal Detectors

1. Thermal detectors shall be intelligent addressable devices rated at 145 degrees Fahrenheit (58 degrees Celsius) and have a rate of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

E. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any normally open dry contact device) to one of the fire alarm control panel SLCs.
2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

F. Two-Wire Detector Monitoring

1. Means shall be provided for the monitoring of conventional Initiating Device Circuits

- populated with 2-wire smoke detectors as well as normally-open contact alarm initiating devices (pull stations, heat detectors, etc).
2. Each IDC of conventional devices will be monitored as a distinct address on the polling circuit by an addressable module. The module will supervise the IDC for alarms and circuit integrity (opens).
 3. The monitoring module will be compatible, and listed as such, with all devices on the supervised circuit.
 4. The IDC zone may be wired for Style D or Style B (Class A or B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
 5. The monitoring module shall be capable of mounting in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or in an surface mount backbox.

G. Addressable Control Relay Module

1. Addressable control relay modules shall be provided to control the operation of fan shutdown and other auxiliary control functions.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control relay module will provide a dry contact, Form-C relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relays may be energized at the same time on the same pair of wires.
4. The control relay module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

3.02 TEST:

The service of a competent, NICET level II technician shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 10.

- A. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- B. Open initiating device circuits and verify that the trouble signal actuates.
- C. Open and short signaling line circuits and verify that the trouble signal actuates.
- D. Open and short notification appliance circuits and verify that trouble signal actuates.
- E. Ground all circuits and verify response of trouble signals.
- F. Check presence and audibility of tone at all alarm notification devices.

- G. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- H. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3 FINAL INSPECTION:

- A. At the final inspection, a minimum NICET Level II technician shall demonstrate that the system functions properly in every respect.

3.4 INSTRUCTION:

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of elevator capture, alternate floor recall and firemen's cap functions shall be provided.

END OF SECTION 28 31 11

SECTION 311000 - SITE CLEARING

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. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and **[removing site utilities] [abandoning site utilities in place]**.
7. Temporary erosion- and sedimentation-control measures.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities[, **and temporary erosion- and sedimentation-control measures**].
2. Division 01 Section "Execution" for field engineering and surveying.
3. Division 01 Section(s) [**"Construction Waste Management and Disposal**] [**and "Sustainable Design Requirements"**] for additional LEED requirements.
4. Division 02 Section "Structure Demolition" for demolition of buildings, structures, and site improvements.
5. Division 02 Section "Selective Structure Demolition" for partial demolition of buildings or structures.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically 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 and is 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 and is 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 more than **2 inches (50 mm)** in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and **[indicated on Drawings] [defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated] <Insert requirement>**.
- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises [**where indicated**] <Insert location>.
- D. Utility Locator Service: Notify [**utility locator service**] [**Miss Utility**] [**Call Before You Dig**] [**Dig Safe System**] [**One Call**] <Insert name> for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control [**and plant-protection**] measures are in place.
- F. The following practices are prohibited within protection zones:
 1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."
 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
- B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with [**MPI #79, Alkyd Anticorrosive Metal Primer**] [**or**] [**SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating**] <Insert manufacturer's name; product name or designation>.
 1. Use coating with a VOC content of [**420 g/L (3.5 lb/gal.)**] <Insert VOC limit> or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain[**or to be relocated**]. **[Flag] [Wrap a 1-inch (25-mm) blue vinyl tie tape flag around] <Insert requirement>** each tree trunk at **54 inches (1372 mm)** above the ground.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site according to requirements in Division 01 Section "Temporary Tree and Plant Protection."
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed[**or abandoned in place**].

1. Arrange with utility companies to shut off indicated utilities.
 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Architect not less than **[two]** **<Insert number>** days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Architect's written permission.
- E. Excavate for and remove underground utilities indicated to be removed.
- F. Removal of underground utilities is included in **[Division 21]** **[Division 22]** **[Division 23]** **[Division 26]** **[Division 27]** **[Division 28]** **[and]** **[Division 33]** Sections.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Grind down stumps and remove roots, obstructions, and debris to a depth of **[18 inches (450 mm)]** **<Insert dimension>** below exposed subgrade.
 3. Use only hand methods for grubbing within protection zones.
 4. Chip removed tree branches and **[stockpile in areas approved by Architect]** **[dispose of off-site]** **<Insert requirement>**.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of **8 inches (200 mm)**, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil **[to depth indicated on Drawings]** **[to depth of 6 inches (150 mm)]** **<Insert requirement>** in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than **2 inches (50 mm)** in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to **72 inches (1800 mm)**.

2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

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 temporary excavation support and protection systems.
- B. Related Sections:
 - 1. Division 01 Section "[**Construction Progress Documentation**] [**Photographic Documentation**]" for recording preexisting conditions and excavation support and protection system progress.
 - 2. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
 - 3. Division 31 Section "Dewatering" for dewatering system for excavations.

1.3 PERFORMANCE REQUIREMENTS

- A. [**Design,**] furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
 - 1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 4. Monitor vibrations, settlements, and movements.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For excavation support and protection system.
- B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified [**land surveyor**] [**and**] [**professional engineer**].

B. Other Informational Submittals:

1. **[Photographs] [or] [Videotape]**: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.
2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.
 - a. Note locations and capping depth of wells and well points.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:
 - a. Geotechnical report.
 - b. Existing utilities and subsurface conditions.
 - c. Proposed excavations.
 - d. Proposed equipment.
 - e. Monitoring of excavation support and protection system.
 - f. Working area location and stability.
 - g. Coordination with waterproofing.
 - h. Abandonment or removal of excavation support and protection system.
 - i. **<Insert agenda items>**.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 1. Notify **[Architect] [Construction Manager] [Owner]** no fewer than **[two] <Insert number>** days 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.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.
 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 2. The geotechnical report is **[included] [referenced]** elsewhere in the Project Manual.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
 1. Corners: **[Site-fabricated mechanical interlock] [Roll-formed corner shape with continuous interlock]**.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of **[size and strength required for application] [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension>**.
- E. Shotcrete: Comply with Division 03 Section "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.
- F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- G. Reinforcing Bars: ASTM A 615/A 615M, **Grade 60 (Grade 420)**, deformed.
- H. Tiebacks: Steel bars, ASTM A 722/A 722M.
- I. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than **[2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment]** <Insert tolerances>.
- B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to **60 inches (1500 mm)**. Accurately align exposed faces of sheet piling to vary not more than **[2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment]** <Insert tolerances>. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

- A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
 - 1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
 - 2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
 - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 1. Remove excavation support and protection systems to a minimum depth of **48 inches (1200 mm)** below overlaying construction and abandon remainder.
 2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
 3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.
- B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

SECTION 315000 – EARTHWORK FOR SMALL PROJECTS

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 DESCRIPTION OF WORK:

- A. Strip soil as herein specified or indicated.
- B. Stockpile surplus topsoil, if any, on site where directed.
- C. Excavation for foundations, rough grading, utility services and extensions. Excavation of all trades is included herein.
- D. Provide additional material hereinafter specified or needed for fills. Remove from site excess material and that which is unsuitable for filling, and legally dispose of it.
- E. Backfilling (including all trades).
- F. Compact fills as hereinafter specified.
- G. Repair any major deformations caused by the removal of large boulders, cave-ins, etc., with concrete, compacted bank run gravel or crushed stone.
- H. Protection and Precautionary Measurements:
 - 1. Carefully maintain bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.
 - 2. Protect active pipes, if encountered, and notify persons owning same. If encountered, remove inactive utilities from within building lines. Plug or cap where indicated or directed.
 - 3. Protect persons and property from damage and discomfort caused by dust. Water as necessary to quell dust.
- I. Erosion Control:
 - 1. Employ satisfactory methods and operations to minimize erosion of soil during earthwork operations. Follow accepted standards of the R.I.D.O.T. for erosion control.

1.3 RELATED WORK UNDER OTHER SECTIONS:

- A. Spreading and/or providing new topsoil - Section 329200 Landscaping.

1.4 ELEVATION AND OBSTRUCTIONS:

- A. The Contract is based upon the following: that the surface elevations, utilities and physical features are as indicated and the contractor shall be responsible to verify its accuracy both underground and overhead. There will be no extra payment for additional work required due to conflicts with the survey information either shown or not shown.
- B. Ground water levels indicated are those existing at the time subsurface investigations were made and do not necessarily represent permanent ground water levels. It is the Contractor's responsibility to determine reasonable variations in ground water levels which may affect the work. There will be no extra payment for any class of rock excavation.

1.5 QUALITY ASSURANCE:

- A. Materials, methods and compaction tests will be subject to approval of an approved inspection agency specified in Section 014000.
- B. Code and Standards: Perform excavation work in compliance with applicable requirement of governing authorities having jurisdiction.

1.6 REQUIREMENTS:

- A. One gradation curve and moisture-density curve for each type of material specified or proposed for use for approval. (AASHTO T-27 and AASHTO T-180)
- B. A minimum of two in-place density tests for each lift of material placed or two for each 200 cubic yards of material placed, whichever results in the greatest number of tests. (AASHTO T-191, T-205 or T-310 In-Place Density Testing by Nuclear Methods)
 - 1. Topsoil Analysis - documenting pH and organic content of on-site material and material to be hauled in.
 - 2. Material delivered to the project shall be tested for compliance with the approved gradation, one test shall be made for each 750 cubic yards of material delivered.
- C. Prior to production and delivery to the site the Contractor shall, together with a representative of the Testing Laboratory chosen by the Owner, obtain at the source two representative 50 lb. samples of all materials proposed for use. Samples shall be placed in lined containers so as to prevent any loss of material during transportation. One sample will be analyzed by the Testing Laboratory for conformance with this specification, should the material be rejected a second at the source sampling shall be made. Upon approval of a material, the second sample taken at the source and not used for analysis shall be delivered by the Testing Laboratory to the Owner's representative at the site for his use. Each sample taken shall be clearly marked as follows:
 - 1. Project Name
 - 2. Architect's Name
 - 3. Contractor's Name
 - 4. Supplier's Name and Source
 - 5. Date Sample Taken
 - 6. Name of Sampler
 - 7. Intended Use and Specification Reference

- D. Test results shall be approved before delivery of any material to the site. Any change in source of materials or quality will require a new series of tests at no additional expense to the Owner.
- E. All unsatisfactory work and any settlement within one (1) year of final acceptance shall be removed, replaced and retested at the Contractor's expense.

1.7 MISCELLANEOUS REQUIREMENTS:

- A. Traffic: Conduct operations and the removal of debris to ensure minimum interference with roads, streets, walks and other adjacent occupied or used facilities.
 - 1. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
 - 2. Provide all traffic control required and pay all costs incurred.
- B. Damages: Promptly repair damages caused to adjacent facilities by operations, as directed and at no additional cost.

PART 2 - PRODUCTS

NOT APPLICABLE.

PART 3 - EXECUTION

3.1 EXCAVATIONS:

- A. Topsoil Removal:
 - 1. Before starting to excavate, strip available topsoil, subsoil and unsuitable material from areas to be covered by improvements and where cuts or fills are required.
 - 2. Topsoil is defined as friable clay from surface soil found in a depth of not less than 4". Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2" in diameter, and without weeds, roots, and other objectionable material.
 - a. pH - 5.5 to 7.6 Organic content - 5% minimum, 20% maximum.
 - 3. Verify depth of topsoil within contract limits. If additional topsoil is needed to fulfill topsoil spread requirements, contractor shall provide topsoil from off-site sources as part of this contract, at his expense.
 - 4. Strip topsoil to whatever depths encountered, unless shown otherwise, and in such manner so as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.
 - 5. Remove unsuitable materials and legally dispose of off site.
 - 6. Stockpile topsoil in storage piles in areas shown, or where otherwise indicated. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent windblown dust. Topsoil remains property of Owner.

B. General Open Earth Excavation:

1. Excavate as necessary for work shown or specified. Remove earth, rocks, boulders, and other obstructions as herein defined.
2. Allow ample space for form work.
3. Leave bearing surfaces undisturbed, level and true. Excavate to solid bearing at elevations no higher than those shown.

C. General Trench Earth Excavation:

1. Excavate trenches for pipe lines along straight lines.
2. Keep trench width at top of pipe to the minimum needed for proper workmanship in installing pipe and making joints.
3. Excavate the bottom of the trenches in earth and rock to the dimensions and depths indicated, below the bottom of all pipes, to provide for gravel bedding beneath the pipes.
4. Whenever wet or otherwise unsuitable soil (that which is incapable of properly supporting pipe as determined by the Architect) is encountered in the bottom of the trench, remove such soil to the depth required. Following the removal of such material, backfill the trench and satisfactorily compact to the proper grade with approved granular backfill.
5. Form under bell ends to allow for jointing and to give the pipe a uniform bearing along the barrel only.

D. Excavation of Existing Pavement:

1. Remove all areas of existing pavement as indicated and as required for the construction of the work under the contract. Where excavation of existing roadway or sidewalk pavement is required, saw cut the existing pavement and remove, to the extent required by the local authorities, leaving straight vertical edges. Any existing pavements beyond these lines so established, which is damaged, or destroyed by the Contractor shall be replaced after the backfill has been placed and approved, restore the pavements to match existing pavements or as required by the local authorities and in an approved manner. All work to comply with local codes and ordinances having jurisdiction.

E. Rock Excavation:

1. Remove all rock to the levels indicated below, or as directed.
2. There will be no extra payment for all classifications of rock removal.
3. Rock is defined as boulders; stone or hard shale in original ledge; concrete footings, foundations, etc.; and other obstructions, in excess of one cubic yard, which cannot be broken and removed from site by normal job equipment (power shovels, 1-1/2 cubic yard capacity scoops, or bulldozers).
4. Level off or shelve rock surfaces to a slope not exceeding one (1) vertical to twelve (12) horizontal, or as directed; before placing masonry or concrete on it.

F. Extent of Rock Removal:

1. For structures or portions thereof: one foot outside the base of walls or footings.

2. For floor slabs or existing building slab removal: six (6) inches below the bottom of slabs on grade.
3. Walks, Plaza, and paved areas: eight (8) inches below the subgrade lines.
4. For pipe trenches: twelve (12) inches outside bell of pipe up to 24" in diameter; and eighteen (18) inches outside bell of pipe over 24" in diameter in a vertical plane and twelve (12) inches below the outside of the pipe barrel.
5. Lawn and shrub areas: eighteen (18) inches below finish grade.

G. Dewatering and Pumping:

1. Provide, construct, and maintain, at no additional expense to the Owner, all pumps, piping, drains, well points, or any other facility for the control and collection of ground water or surface water. Provide dewatering operations of such a nature so that all excavations are kept, at all times, free from water, so that all construction is performed in a dry working area, including soil for a minimum distance of 1'-0" below foundations and footings. Repair any damage resulting from the failure of the dewatering operations and any damage resulting from the failure to maintain the area of all structure and work in a suitably dry condition as directed by the Architect, and at no additional expense to the Owner. Perform the pumping and dewatering operations in such a manner, that no loss of ground/soils will result from these operations. Take necessary precautions to protect new and existing work from flooding during storms and from other causes. Provide continuous pumping where required to protect the work and/or to maintain satisfactory progress. All pipelines or structures not stable against uplift during construction or prior to completion shall be thoroughly braced or otherwise protected. Water shall not be conducted onto adjacent property.

H. Unauthorized Excavation:

1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect.
 - a. Under footings, foundation bases or retaining walls, fill unauthorized excavation by extending the indicated bottom elevation of the footing or base to the excavation bottom without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, only when acceptable.
 - b. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed.
 - c. Do all corrective work as specified above at no expense to the Owner.

I. Stability of Excavations:

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible either because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

J. Shoring and Bracing:

1. Brace and shore sides of excavation as necessary to prevent danger to persons or damage to structures, injurious caving or erosion.
2. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and crossbraces, in good serviceable condition.
3. Provide shoring and bracing to comply with local codes and authorities having jurisdiction.
4. Maintain shoring and bracing in excavation regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
 - a. Repair slides and cave-ins should they occur.
 - b. Remove shoring and bracing before backfilling.
 - c. In removing shoring and bracing, exercise care to prevent voids. Immediately fill voids, if formed, with approved fill material.

K. Water and Frost:

1. Keep earth under footings and slabs dry and free from frost.
2. Should bearing surfaces be softened by water or frost, re-excavate to solid bearing and fill with concrete or gravel as directed at no expense to Owner.

3.2 FILLING:

A. General:

1. Remove debris and organic matter before filling.
2. Use approved materials only for fills.
3. Obtain Architect's approval before filling.
4. Make fills as soon as feasible thereafter to insure maximum settlement.
5. Do not place fill on frozen ground.
6. Provide all material free from frost, roots and other vegetable matter, large rocks, rubbish, brick and other undesirable material.
7. Install fills in indicated thicknesses.
8. Provide neat, uniform side slopes (smooth and graded) to those excavations not required to be filled.

B. Fill Materials: Unless specifically shown otherwise, use the following materials:

1. "Graded Gravel Fill" (under slab on grade at building, Plaza and sidewalks; although a similar graded bank-run gravel may be acceptable) free from loam, recycled materials, and other specified undesirable materials, conforming to the following analysis:

Sieve Size	% Passing by Weight
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3"	100
1-1/2"	75-95
3/4"	60-85
3/8"	45-75
#4	30-65
#40	6-25
#200	0-4

- a. On-site material may be used under Plaza and sidewalks areas only after satisfactory test data has been submitted, and only with the Architect's approval.
2. "Bank Run Gravel" in pipe trenches, around manholes and catch basins, against dampproofed foundation walls, where indicated as "gravel fill", and where else shown, free from loam, recycled materials, and other specified undesirable material, and conforming to the following analysis:

Sieve Size	% Passing by Weight
3"	100
1/2"	50-85
3/8"	45-80
#4	40-75
#40	15-35
#200	0-8

- a. On-site material may be used, only after satisfactory test data has been submitted, and only with the Architect's approval.
3. "Stone" (to stabilize utilities and foundations as necessary and where indicated) conforming to the following analysis:

Sieve Size	% Passing by Weight
2-1/4"	100
2"	90-100
1-1/2"	30-55
1-1/4"	0-25
1"	0-5
#200	0

4. "Filter Stone" (around french drains and combination drains, at retaining walls and where else indicated) shall be washed and free from clay, silt, organic matter, or other objectionable material and conforming to the following analysis:

Sieve Size	% Passing by Weight
1"	100
3/4"	70-85
1/2"	10-40
3/8"	0-20
#4	0-5
#200	0

5. "Sand" (if indicated) consisting of clean, inert, hard, durable grains of quartz or other hard durable rock; free from loam or clay, surface coatings and deleterious material; and conforming to the following analysis:

Sieve Size	% Passing by Weight
#8	100
#50	25-40
#100	0-10

#200 0-5

6. Fill Material for Trenches:
 - a. Bedding for pipe - "Bank Run Gravel", except with 100% passing 3/4" sieve (stone if unsuitable material is encountered).
 - b. Over pipe - Two 6" layers of "Bank Run Gravel", except with 100% passing 3/4" sieve.
 - c. Remaining Fill - "Bank Run Gravel"; approved on-site or new material, free from stones over 4" diameter and other specified undesirable materials.
7. Fill Material for Other Areas:
 - a. Any of the aforementioned.
 - b. Excess on-site material, as approved.

3.3 COMPACTION:

A. General:

1. Prior to the placement of any fill or backfill, the natural ground under the building area and areas to be paved shall be compacted using an approved vibratory compactor. Where area is sufficient for proof rolled with vehicle, provide at least two passes of a fully loaded ten wheel dump truck or equivalent to verify firm ground, in areas inaccessible to proof rolling, an approved vibratory compactor shall be used.
2. Place fill in horizontal layers, beginning with the lowest areas and building up until the entire area to be filled is at a uniform elevation.
3. Compact each layer with an approved vibratory device to achieve minimum density requirements.
4. Continue compaction of each layer until there is no evidence of weaving or creeping. Compact places inaccessible to large equipment with approved mechanical tampers as well as around the perimeter of foundations, walls and around column pedestals and footings.
5. Do not use rolling equipment in the area adjacent to the foundation and retaining walls.
6. Earth in cut sections for roadway and parking lot areas shall be excavated to subgrade. The resulting surface of the cut shall be compacted as required, to not less than 95% of maximum density.
7. Earth in embankment section for roadway and parking lot areas, below a plane of one foot below subgrade shall be compacted to not less than 95% of maximum density in 12 inch loose layers.
8. Remainder of the roadway section up to subgrade shall be compacted to 95% of maximum density in two 6 inch layers.
9. For compaction within building areas and/or beneath structures with foundations, see "Controlled Compacted Fill".

10. Elsewhere, compact to 95% of maximum density in 12 inch loose layers, except for two 6 inch layers directly over pipes.
11. Attention is directed to the grain size characteristics of the material and necessity for and difficulty of controlling and maintaining optimum moisture content during compaction. Material in each layer shall contain optimum moisture for maximum density compaction and the optimum moisture content shall be uniformly distributed throughout the layer. Harrowing or other working of the material may be required to produce uniformity and control of the water content.
12. Slope the surface of each layer 1%, plus or minus .25% at the conclusion of each day's work to provide surface drainage.
13. Maximum density for compacted soils shall be determined by ASTM D 1557, Method C.
14. Whenever in-place densities are below minimum acceptable limits, as determined by AASHTO T-191, T-205 or T-310 In-Place Density Testing by Nuclear Methods, additional compaction will be required to produce the specified densities, without additional cost to the Owner. When greater densities than the minimum specified are required by the Architect, the work will be subject to contract unit prices.

3.4 CONTROLLED COMPACTED FILL:

- A. All fills within the building area and/or beneath foundations shall be constructed prior to construction of foundations and shall be constructed under laboratory control to result in 98% of maximum density at optimum moisture below footing elevations and 95% of maximum density from elevation of bottom of footing to underside of slab. The extent of this fill is within 3 feet of foundations, proceeding out at a 45 degree angle, or as indicated on the site plan and in the typical earthwork section, or as directed.
- B. Retain a laboratory and Geotechnical Engineer approved by the Architect, to supervise and control the construction of the fill. This laboratory shall perform tests in accordance with ASTM D 1557 on the materials the Contractor proposed to use to establish the compacted dry weight at optimum moisture. Results of these tests shall be submitted to the Architect for approval and work may start only after the Architect approves the test results. The Architect, or approved testing laboratory under the direction of the Architect, shall provide continuous inspection of compacted fills.
- C. Backfilling material shall conform to laboratory requirements herein specified and shall be soil obtained from an approved borrow pit.
- D. The area to be filled shall be cleared of all loose material and inspected and approved by the Geotechnical Engineer.
 1. Fill material shall be free from frost and shall not be placed on frozen ground. Fill shall be deposited in layers of such thickness as required by its nature or as directed, but the uncompacted thickness of each layer shall not exceed 8".
 2. Each layer shall be separately compacted to a uniform solid mass by use of vibratory compactors or other approved equipment. Fill shall be placed in horizontal layers, beginning with the lowest areas and building up until the entire area to be filled is at a uniform elevation.

3. The Contractor shall control the moisture content of the fill material, as directed by the laboratory to insure maximum density by either the addition of water, or by harrowing and working prior to compacting.
4. Each layer shall be free of ruts and shall meet compaction requirements before a succeeding layer is placed. Compaction of each layer shall continue until no weaving or creeping takes place.
- E. Backfill in areas excavated after construction of the fill shall be constructed in layers whose loose thickness shall not exceed 6" and shall be thoroughly compacted with approved hand equipment to the density hereinbefore specified.
- F. Field tests of moisture content prior to compaction and dry weight after compaction shall be made by the laboratory to insure thorough and uniform compaction. Testing shall be performed on the layer just compacted.
- G. At least two tests of moisture content shall be made each day. Additional tests shall be made if material or moisture conditions change.

3.5 ROUGH GRADING:

A. General:

1. Grade entire area of work area on property to reasonably true and even surfaces, thoroughly compacted to indicated elevations.
2. Slope ground away from existing and/or new building walls to facilitate drainage.
3. Grade to uniform levels or slopes between points where grades are noted or as necessary to facilitate proper drain per building codes.
4. Round surfaces at abrupt changes in levels.
5. Should figures conflict with contours, consult Architect.

B. Levels:

1. Grade paving, walks and other surfaces areas to subgrade.
2. Grade lawn areas to 6" below finish grades.
3. Ground cover areas to 9" below finish grade.
4. Shrub beds to 3" below finish grade.

C. Grading Around Trees:

1. Raising Grade: (not more than 16 inches)
2. Place washed gravel directly around trunk before any earth fill is placed near tree.
3. Extend gravel not less than 18 inches around all sides of tree, top approximately 2 inches above finished grade at tree.

D. Lowering Grades:

1. Do regrading by hand to levels and extent indicated.
2. Cut roots as required 3 inches inside bank, and paint ends with tree wound paint.

3.6 USE OF EXPLOSIVES:

- A. The use of explosives will not be permitted.

- B. Mechanical means shall be employed for rock removal.
- C. Non explosives agents such as Bustar (formally called Bristar) may be used when approved by Owner and Architect prior.

END OF SECTION 31 50 05

SECTION 321313 - CONCRETE PAVING

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. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

B. Related Sections:

1. Division 03 Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]" for general building applications of concrete.
2. Division 32 Section "Decorative Concrete Paving" for stamped concrete other than detectable warnings. Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]" for general building applications of concrete.
3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Indicate 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 product, ingredient, or admixture requiring color selection.
- D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
 1. **Exposed Aggregate:** [10-lb (4.5-kg)] <Insert weight> Sample of each mix.

- 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. Qualification Data: For qualified [Installer of detectable warnings] and [ready-mix concrete manufacturer]
- B. 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.
- C. 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.]
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. 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 that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- E. ACI Publications: Comply with **ACI 301** (**ACI 301M**) unless otherwise indicated.
- F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. **Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than [96 inches (2400 mm) by 96 inches.**
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. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at 600 Mount Pleasant Street Providence, RI.

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.
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 detectable warnings.

1.7 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of **[40 deg F (4.4 deg C) for oil-based materials] [55 deg F (12.8 deg C) for water-based materials]**, and not exceeding **95 deg F (35 deg C)**.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 1. **Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. [Do not use notched and bent forms.]**
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] <Insert number> percent.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from [as-drawn] [galvanized]-steel wire into flat sheets.
- C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- D. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
- E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
- F. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
- G. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
- H. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.
- I. Plain-Steel Wire: ASTM A 82/A 82M, [as drawn] [galvanized].
- J. Deformed-Steel Wire: ASTM A 496/A 496M.
- K. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, [plain] [deformed].
- L. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating]. Cut bars true to length with ends square and free of burrs.
- M. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.
- N. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- O. Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- P. 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.
- Q. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

- R. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
- Portland Cement:** ASTM C 150, [gray] [white] portland cement [Type I] [Type II] [Type I/II] [Type III] [Type V]. [Supplement with the following:]
 - Fly Ash: ASTM C 618, [Class C] [or] [Class F].
 - Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - Blended Hydraulic Cement:** ASTM C 595, [Type IS, portland blast-furnace slag] [Type IP, portland-pozzolan] cement.
- B. Normal-Weight Aggregates: ASTM C 33, [Class 4S] [Class 4M] [Class 1N] <Insert class>, 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].
- Maximum Coarse-Aggregate Size: [1-1/2 inches (38 mm)] [1 inch (25 mm)] [3/4 inch (19 mm)] nominal.
 - Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
- Aggregate Sizes:** [3/4 to 1 inch (19 to 25 mm)] [1/2 to 3/4 inch (13 to 19 mm)] [3/8 to 5/8 inch (10 to 16 mm)] <Insert dimensions> nominal.
 - Aggregate Source, Shape, and Color:** <Insert requirements>.
- D. Water: Potable and complying with ASTM C 94/C 94M.
- E. Air-Entraining Admixture: ASTM C 260.
- F. 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.
- Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - Retarding Admixture: ASTM C 494/C 494M, Type B.
 - Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- G. 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.
- Manufacturers:** Subject to compliance with requirements, [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]:
 - ChemMasters.
 - Davis Colors.

- c. Dayton Superior Corporation.
 - d. Elementis Pigments.
 - e. Hoover Color Corporation.
 - f. Lambert Corporation.
 - g. LANXESS Corporation.
 - h. QC Construction Products.
 - i. Scofield, L. M. Company.
 - j. Solomon Colors, Inc.
 - k. Stampcrete International, Ltd.
 - l. SureCrete Design Products.
 - m. <Insert manufacturer's name>.
2. **Color:** [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

2.4 FIBER REINFORCEMENT

- A. Synthetic Fiber: [Monofilament] [or] [fibrillated] polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**] <Insert dimensions> long.
1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
- a. Monofilament Fibers:
 - 1) Axim Italcementi Group, Inc.; FIBRASOL II P.
 - 2) Euclid Chemical Company (The), an RPM company; Fiberstrand 100, Fiberstrand 150.
 - 3) FORTA Corporation; [**FORTA ECONO-MONO**] [or] [**FORTA Mighty-Mono**].
 - 4) Grace, W. R. & Co. - Conn.; Grace MicroFiber.
 - 5) Metalcrete Industries; Polystrand 1000.
 - 6) QC Construction Products; QC FIBERS.
 - 7) <Insert manufacturer's name; product name or designation>.
 - b. Fibrillated Fibers:
 - 1) Axim Italcementi Group, Inc.; FIBRASOL F.
 - 2) Euclid Chemical Company (The), an RPM company; Fiberstrand F.
 - 3) FORTA Corporation; [**FORTA Econo-Net**] [or] [**FORTA Super-Net**].
 - 4) Grace, W. R. & Co. - Conn.; Grace Fibers.
 - 5) Propex Concrete Systems Corp.; Fibermesh 300.
 - 6) <Insert manufacturer's name; product name or designation>.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, [**Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry**] [or] [cotton mats].
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.
 - b. BASF Construction Chemicals, LLC; Confilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec by Dayton Superior; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film (J-74).
 - f. Edoco by Dayton Superior; BurkeFilm.
 - g. Euclid Chemical Company (The), an RPM company; Eucobar.
 - h. Kaufman Products, Inc.; VaporAid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-CON.
 - k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; MONOFILM.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
 - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; PRO-FILM.
 - s. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.
 - t. <Insert manufacturer's name; product name or designation>.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Anti-Hydro International, Inc.; A-H Curing Compound #2 DR WB.
 - b. ChemMasters; Safe-Cure Clear.
 - c. Conspec by Dayton Superior; [D.O.T. Resin Cure] [DSSCC Clear Resin Cure].
 - d. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
 - e. Edoco by Dayton Superior; [DSSCC Clear Resin Cure] [Resin Emulsion Cure V.O.C. (Type I)].
 - f. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; AQUA KURE - CLEAR.
 - i. L&M Construction Chemicals, Inc.; L&M CURE R.
 - j. Meadows, W. R., Inc.; 1100-CLEAR SERIES.
 - k. Nox-Crete Products Group; Resin Cure E.
 - l. SpecChem, LLC; PaveCure Rez.
 - m. Symons by Dayton Superior; Resi-Chem Clear.
 - n. Tamms Industries, Inc., Euclid Chemical Company (The); TAMMSCURE WB 30C.
 - o. TK Products, Division of Sierra Corporation; [TK-2519 WB] [TK-2519 DC WB].
 - p. Vexcon Chemicals Inc.; Certi-Vex EnvioCure 100.
 - q. <Insert manufacturer's name; product name or designation>.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Anti-Hydro International, Inc.; A-H Curing Compound #2 WP WB.
 - b. ChemMasters; Safe-Cure 2000.
 - c. Conspec by Dayton Superior; **[D.O.T. Resin Cure White] [DSSCC White Resin Cure]**.
 - d. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).
 - e. Edoco by Dayton Superior; Resin Emulsion Cure V.O.C. (Type II).
 - f. Euclid Chemical Company (The), an RPM company; Kurez VOX White Pigmented.
 - g. Kaufman Products, Inc.; Thinfilm 450.
 - h. Lambert Corporation; AQUA KURE - WHITE.
 - i. L&M Construction Chemicals, Inc.; L&M CURE R-2.
 - j. Meadows, W. R., Inc.; 1100-WHITE SERIES.
 - k. SpecChem, LLC; PaveCure Rez White.
 - l. Symons by Dayton Superior; Resi-Chem White.
 - m. Vexcon Chemicals Inc.; Certi-Vex Enviocure White 100.
 - n. **<Insert manufacturer's name; product name or designation>**.

2.6 RELATED MATERIALS

- A. Joint Fillers: **[ASTM D 1751, asphalt-saturated cellulosic fiber] [or] [ASTM D 1752, cork or self-expanding cork]** 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 C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. 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, of grade complying with requirements, and of the following types:
 1. **[Types I and II, non-load bearing] [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 (3 to 6 mm)**.
 1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. ChemMasters; Exposee.
 - b. Conspec by Dayton Superior; Delay S.
 - c. Dayton Superior Corporation; Sure Etch (J-73).
 - d. Edoco by Dayton Superior; True Etch Surface Retarder.
 - e. Euclid Chemical Company (The), an RPM company; Surface Retarder Formula S.
 - f. Kaufman Products, Inc.; Expose.
 - g. Meadows, W. R., Inc.; TOP-STOP.
 - h. Metalcrete Industries; Surfard.

- i. Nox-Crete Products Group; CRETE-NOX TA.
 - j. Scofield, L. M. Company; LITHOTEX Top Surface Retarder.
 - k. Sika Corporation, Inc.; Rugasol-S.
 - l. SpecChem, LLC; Spec Etch.
 - m. TK Products, Division of Sierra Corporation; TK-6000 Concrete Surface Retarder.
 - n. Unitex; TOP-ETCH Surface Retarder.
 - o. Vexcon Chemicals Inc.; Certi-Vex Envioset.
 - p. <Insert manufacturer's name; product name or designation>.
- F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Anti-Hydro International, Inc.; A-H S-Q Hardener.
 - b. BASF Construction Chemicals, LLC; Mastercron.
 - c. ChemMasters; ConColor.
 - d. Conspec by Dayton Superior; Conshake 600 Colortone.
 - e. Dayton Superior Corporation; Quartz Tuff.
 - f. Euclid Chemical Company (The), an RPM company; Surfex.
 - g. Lambert Corporation; COLORHARD.
 - h. L&M Construction Chemicals, Inc.; QUARTZPLATE FF.
 - i. Metalcrete Industries; Floor Quartz.
 - j. Scofield, L. M. Company; LITHOCHROME Color Hardener.
 - k. Southern Color N.A., Inc.; Mosaics Color Hardener.
 - l. Stampcrete International, Ltd.; Color Hardener.
 - m. Symons by Dayton Superior; Hard Top.
 - n. <Insert manufacturer's name; product name or designation>.
 2. **Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.**
- G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch (9.5-mm) sieve and 85 percent retained on a No. 8 (2.36-mm) sieve.

2.7 DETECTABLE WARNING MATERIALS

- A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
1. **Manufacturers: Subject to compliance with requirements, [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. Advanced Surfaces Inc.
 - b. Matcrete Precision Stamped Concrete Tools.
 - c. Southern Color N.A., Inc.
 - d. Stampcrete International Ltd.
 - e. Superior Decorative by Dayton Superior.
 - f. <Insert manufacturer's name>.
 2. **Size of Stamp: One piece [matching detectable warning area shown on Drawings] [24 by 24 inches (610 by 610 mm)] [24 by 36 inches (610 by 914 mm)] [24 by 48 inches**

(610 by 1220 mm)] [26 by 26 inches (660 by 660 mm)] [26 by 36 inches (660 by 914 mm)] <Insert dimensions>.

- B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.
1. **Products:** Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Advanced Surfaces Inc.; Liquid Release.
 - b. Matcrete Precision Stamped Concrete Tools; Liquid Release Agent.
 - c. Southern Color N.A., Inc.; SCC Clear Liquid Release.
 - d. Stampcrete International Ltd.; Stampcrete Liquid Release.
 - e. Superior Decorative by Dayton Superior; Pro Liquid Release.
 - f. <Insert manufacturer's name; product name or designation>.

2.8 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), 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 meet or exceed requirements.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
1. **Compressive Strength (28 Days):** [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength>.
 2. **Maximum Water-Cementitious Materials Ratio at Point of Placement:** [0.45] [0.50] <Insert ratio>.
 3. **Slump Limit:** [4 inches (100 mm)] [5 inches (125 mm)] [8 inches (200 mm)] <Insert dimension>, plus or minus 1 inch (25 mm).
- 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:** [5-1/2] [4-1/2] [2-1/2] percent plus or minus 1.5 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.
 2. **Air Content:** [6] [4-1/2] [3] percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.
 3. **Air Content:** [6] [5] [3-1/2] percent plus or minus 1.5 percent for 3/4-inch (19-mm) nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to [0.15] [0.30] 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. Cementitious Materials: [**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.**][**Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:**]
1. Fly Ash or Pozzolan: 25 percent.
 2. Ground Granulated Blast-Furnace Slag: 50 percent.
 3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than [1.0 lb/cu. yd. (0.60 kg/cu. m)] [1.5 lb/cu. yd. (0.90 kg/cu. m)] <Insert requirement>.
- H. 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.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M [**and ASTM C 1116/C 1116M**]. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between **85 and 90 deg F (30 and 32 deg C)**, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above **90 deg F (32 deg C)**, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For concrete batches of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 2. For concrete batches larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

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] <Insert locations> 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 (5 km/h).**
 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.

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3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of [1/2 inch (13 mm)] <Insert dimension> according to requirements in Division 31 Section "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 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. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. 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 D 3963/D 3963M.
- G. 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 (50-mm)** 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 (38 mm)** 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 (15.25 m)] <Insert dimension> unless otherwise indicated.**
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** 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 (6-mm)] [3/8-inch (10-mm)] 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 (75 mm)] <Insert dimension>** either way from centers of dowels.
 2. Sawn Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3-mm-)** 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 (75 mm)] <Insert dimension>** 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 (6-mm)] [3/8-inch (10-mm)]** 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 (ACI 301M)** 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 (ACI 301M)** 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 bleed water 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.
- L. Cold-Weather 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 (4.4 deg C)**, uniformly heat water and aggregates before mixing to obtain a concrete mixture

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temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) 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.

M. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) 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.**

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 bleed-water 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 (1.6 to 3 mm) 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 (1.6 mm)**.
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. (12 kg/10 sq. m)] [40 lb/100 sq. ft. (19.5 kg/10 sq. m)] [60 lb/100 sq. ft. (29 kg/10 sq. m)] <Insert rate of application> of dampened, slip-resistive 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-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive 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-resistive 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.
- D. Rock-Salt Finish: After initial **[floating] [troweling] [brooming]**, uniformly spread rock salt over paving surface at the rate of **5 lb/100 sq. ft. (0.2 kg/10 sq. m)**.
1. **Embed rock salt into plastic concrete with [roller] [or] [magnesium float] <Insert tool>.**
 2. Cover paving surface with **1-mil- (0.025-mm-)** thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
 3. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.
- E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:
1. **Uniformly spread dry-shake hardener at a rate of [100 lb/100 sq. ft. (49 kg/10 sq. m)] <Insert rate of application>, unless greater amount is recommended by manufacturer to match paving color required.**
 2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
 3. After final power floating, apply a hand-trowel finish followed by a broom finish.
 4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 DETECTABLE WARNINGS

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in **[Division 32 Section "Unit Paving"] <Insert Division number and Section title>**.
1. **Tolerance for Opening Size: [Plus 1/4 inch (6 mm), no minus] <Insert requirement>**.
- B. 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] <Insert number> 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 (1 kg/sq. m 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] [or] [a combination of these]** 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 (300-mm)** 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 (300 mm)** 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 that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.11 PREFORMED TRAFFIC-CALMING DEVICES

- A. Install preformed speed **[bumps]** **[humps]** **[cushions]** in bed of adhesive applied as recommended by manufacturer for heavy traffic.
- B. Securely attach preformed speed **[bumps]** **[humps]** **[cushions]** to paving with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least one composite sample for each **[100 cu. yd. (76 cu. m)]** **[5000 sq. ft. (465 sq. m)]** 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 shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; 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 C 231, 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 C 1064/C 1064M; one test hourly when air temperature is **40 deg F (4.4 deg C)** and below and when it is **80 deg F (27 deg C)** and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall 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 (3.4 MPa)**.

- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall 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 shall 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 REPAIRS 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 321373 - CONCRETE PAVING JOINT SEALANTS

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. Cold-applied joint sealants.
2. Cold-applied, jet-fuel-resistant joint sealants.
3. Hot-applied joint sealants.
4. Hot-applied, jet-fuel-resistant joint sealants.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
2. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
3. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 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]** **[manufacturer's standard test method]** 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 no fewer than **[eight]** **<Insert number>** pieces of each type 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 compatibility with and adhesion to joint substrates and other materials matching those submitted.

CONCRETE PAVING JOINT SEALANTS

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Pavement-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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified [**Installer**] [**testing agency**].
- B. Product Certificates: For each type of joint sealant and accessory, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.
- D. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.6 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 type 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.
- D. Preinstallation Conference: Conduct conference at [**Project site**] <Insert location>.

1.7 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

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1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below 40 deg F (5 deg C)**].
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.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backing materials, 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. Colors of Exposed Joint Sealants: **[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color>**.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Crafcro Inc., an ERGON company; RoadSaver Silicone.
 - b. Dow Corning Corporation; 888.
 - c. Pecora Corporation; 301 NS.
 - d. **<Insert manufacturer's name; product name or designation>**.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Crafcro Inc., an ERGON company; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Pecora Corporation; 300 SL.
 - d. **<Insert manufacturer's name; product name or designation>**.
- C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.

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1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Pecora Corporation; Urexpan NR-200.
 - b. **<Insert manufacturer's name; product name or designation>**.

2.3 COLD-APPLIED, JET-FUEL-RESISTANT JOINT SEALANTS

- A. Jet-Fuel-Resistant, Single-Component, Pourable, Traffic-Grade, Modified-Urethane Joint Sealant for Concrete: ASTM C 920, Type S, Grade P, Class 25, for Use T.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. BASF Building Systems; Sonomeric 1.
 - b. **<Insert manufacturer's name; product name or designation>**.
- B. Jet-Fuel-Resistant, Multicomponent, Pourable, Traffic-Grade, Modified-Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 12-1/2, for Use T.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Pecora Corporation; Urexpan NR-300.
 - b. **<Insert manufacturer's name; product name or designation>**.
- C. Jet-Fuel-Resistant, Multicomponent, Pourable, Traffic-Grade, Modified-Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Meadows, W. R., Inc.; Sealtight Gardox.
 - b. **<Insert manufacturer's name; product name or designation>**.

2.4 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Crafco Inc., an ERGON company; Superseal 444/777.
 - b. **<Insert manufacturer's name; product name or designation>**.

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- B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Meadows, W. R., Inc.; **[Sealtight Hi-Spec] [Sealtight 3405]**.
 - b. Right Pointe; D-3405 Hot Applied Sealant.
 - c. **<Insert manufacturer's name; product name or designation>**.

2.5 HOT-APPLIED, JET-FUEL-RESISTANT JOINT SEALANTS

- A. Hot-Applied, Jet-Fuel-Resistant, Single-Component Joint Sealant for Concrete: ASTM D 7116, Type I.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Crafcro Inc., an ERGON company; Superseal 444/777.
 - b. **<Insert manufacturer's name; product name or designation>**.
- B. Hot-Applied, Jet-Fuel-Resistant, Single-Component Joint Sealant for Concrete and Tar Concrete: Single-component formulation complying with ASTM D 3581.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Crafcro Inc., an ERGON company; Superseal 1614A.
 - b. **<Insert manufacturer's name; product name or designation>**.

2.6 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

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2.7 PRIMERS

- A. Primers: Product 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.

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.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on 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.

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. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install joint-sealant backings of kind indicated to support joint 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 joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place joint sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.

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3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements 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 joint sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess joint 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.

3.5 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 and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within cement concrete pavement[<PJS-#>].
 1. Joint Location:
 - a. Expansion and isolation joints in cast-in-place concrete pavement.
 - b. Contraction joints in cast-in-place concrete slabs.
 - c. <Insert joints>.
 - d. Other joints as indicated.
 2. Silicone Joint Sealant for Concrete: [**Single component, nonsag**] [**Single component, self-leveling**] <Insert joint sealant>.
 3. Urethane Joint Sealant for Concrete: [**Multicomponent, pourable, traffic-grade**] <Insert joint sealant>.
 4. Hot-Applied Joint Sealant for Concrete: [**Single component**] <Insert joint sealant>.
 5. Joint-Sealant Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.

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- B. Joint-Sealant Application: Fuel-resistant joints within cement concrete pavement[<PJS-#>].
1. Joint Location:
 - a. Expansion and isolation joints in cast-in-place concrete pavement.
 - b. Contraction joints in cast-in-place concrete slabs.
 - c. <Insert joints>.
 - d. Other joints as indicated.
 2. Jet-Fuel-Resistant, Modified-Urethane Joint Sealant for Concrete: [**Single-component, pourable, traffic-grade**] [**Multicomponent, pourable, traffic-grade, Class 12-1/2**] [**Multicomponent, pourable, traffic-grade, Class 25**] <Insert joint sealant>.
 3. Hot-Applied, Jet-Fuel-Resistant, Joint Sealant for Concrete: [**Single component**] <Insert joint sealant>.
 4. Joint-Sealant Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.
- C. Joint-Sealant Application: Joints between cement concrete and asphalt pavement[<PJS-#>].
1. Joint Location:
 - a. Joints between concrete and asphalt pavement.
 - b. Joints between concrete curbs and asphalt pavement.
 - c. <Insert joints>.
 - d. Other joints as indicated.
 2. Hot-Applied Joint Sealant for Concrete and Asphalt: [**Single component**] <Insert joint sealant>.
 3. Joint-Sealant Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.
- D. Joint-Sealant Application: Fuel-resistant joints between cement concrete and tar-concrete pavement[<PJS-#>].
1. Joint Location:
 - a. Joints between concrete and tar-concrete pavement.
 - b. Joints between concrete curbs and tar-concrete pavement.
 - c. <Insert joints>.
 - d. Other joints as indicated.
 2. Hot-Applied, Jet-Fuel-Resistance Joint Sealant for Concrete and Tar Concrete: [**Single component**] <Insert joint sealant>.
 3. Joint-Sealant Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.

END OF SECTION 321373

CONCRETE PAVING JOINT SEALANTS.

SECTION 329200 - TURF AND GRASSES

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. Seeding.
2. Hydroseeding.
3. Sodding.
4. Plugging.
5. Sprigging.
6. Meadow grasses and wildflowers.
7. Turf renovation.
8. Erosion-control material(s).
9. Grass paving.

B. Related Sections:

1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
3. Division 32 Section "Porous Unit Paving" for concrete grid-type pavers shaped to provide open areas between units, planted with grass or other plants.
4. Division 32 Section "Planting Irrigation " for turf irrigation.
5. Division 32 Section "Plants" for border edgings.
6. Division 33 Section "Subdrainage" for subsurface drainage.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.5 INFORMATIONAL SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for **[turfgrass sod] [plugs]**. Include identification of source and name and telephone number of supplier.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For **[soil amendments] [and] [fertilizers]**, from manufacturer.
- D. Material Test Reports: For **[standardized ASTM D 5268 topsoil] [existing native surface topsoil] [existing in-place surface soil] [and] [imported or manufactured topsoil]**.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf **[and meadows]** during a calendar year. Submit before expiration of required initial maintenance periods.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf **[and meadow]** establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Experience: **[Three] [Five] <Insert number>** years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's **[field supervisor] [personnel assigned to the Work]** shall have certification in **[one of] [all of]** the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with **[installation] [maintenance] [irrigation]** specialty area(s), designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
 5. Maintenance Proximity: Not more than **[two] <Insert number>** hours' normal travel time from Installer's place of business to Project site.
 6. Pesticide Applicator: State licensed, commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; **[sodium absorption ratio;]**deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of **[three] <Insert number>** representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per **1000 sq. ft. (92.9 sq. m)** or volume per **cu. yd. (0.76 cu. m)** for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- C. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers[, **lime**,] and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
1. Spring Planting: **<Insert dates>**.
 2. Fall Planting: **<Insert dates>**.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.9 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
1. Seeded Turf: **[60]** **<Insert number>** days from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
 2. Sodded Turf: **[30]** **<Insert number>** days from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
 3. Plugged Turf: **[30]** **<Insert number>** days from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
 4. Sprigged Turf: **[30]** **<Insert number>** days from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
- B. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than **[40]**

<Insert number> days from date of [planting completion] [Substantial Completion] <Insert starting time>.

- C. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species as follows:
- C. Seed Species: Seed of grass species as follows, with not less than [95] <Insert number> percent germination, not less than [85] <Insert number> percent pure seed, and not more than [0.5] <Insert number> percent weed seed:
1. Full Sun: Bermudagrass (*Cynodon dactylon*).
 2. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 3. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 4. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).
- D. Grass Seed Mix: Proprietary seed mix as follows:
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. <Insert manufacturer's name; product name or designation>.

2.2 TURFGRASS SOD

- A. Turfgrass Sod: [Certified] [Approved] [Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects], complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

- B. Turfgrass Species: [**Bermudagrass (Cynodon dactylon)**] [**Carpetgrass (Axonopus affinis)**] [**Centipedegrass (Eremochloa ophiuroides)**] [**St. Augustinegrass (Stenotaphrum secundatum)**] [**Zoysiagrass (Zoysia japonica)**] [**Zoysiagrass (Zoysia matrella)**] <Insert species>.
- C. Turfgrass Species: Sod of grass species as follows, with not less than [95] <Insert number> percent germination, not less than [85] <Insert number> percent pure seed, and not more than [0.5] <Insert number> percent weed seed:
1. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 2. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 3. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

2.3 PLUGS

- A. Plugs: Turfgrass sod, [**certified**] [**approved**] [**Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects**], complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, cut into square or round plugs, strongly rooted, and capable of vigorous growth and development when planted; of the following turfgrass species and plug size:
1. Turfgrass Species: [**Bermudagrass (Cynodon dactylon)**] [**Carpetgrass (Axonopus affinis)**] [**Centipedegrass (Eremochloa ophiuroides)**] [**St. Augustinegrass (Stenotaphrum secundatum)**] [**Zoysiagrass (Zoysia japonica)**] [**Zoysiagrass (Zoysia matrella)**] <Insert species>.
 2. Plug Size: [**2 inches (50 mm)**] [**3 inches (75 mm)**] [**4 inches (100 mm)**] <Insert size>.

2.4 SPRIGS

- A. Sod Sprigs: Healthy living stems, rhizomes, or stolons with a minimum of two nodes and attached roots free of soil, of the following turfgrass species:
1. Turfgrass Species: [**Bermudagrass (Cynodon dactylon)**] [**Carpetgrass (Axonopus affinis)**] [**Centipedegrass (Eremochloa ophiuroides)**] [**St. Augustinegrass (Stenotaphrum secundatum)**] [**Zoysiagrass (Zoysia japonica)**] [**Zoysiagrass (Zoysia matrella)**] <Insert species>.
 2. Turfgrass Species: Creeping bentgrass (*Agrostis palustris*).

2.5 MEADOW GRASSES AND WILDFLOWERS

- A. Wildflower Seed: Fresh, clean, and dry new seed, of mixed species as follows:
 - 1. **<Insert mix of wildflower species>**.
- B. Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as follows:
 - 1. **<Insert mix of native grass species>**.
- C. Wildflower and Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as follows:
 - 1. **<Insert mix of wildflower and native grass species>**.
- D. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.6 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: T, with a minimum of 99 percent passing through **No. 8 (2.36-mm)** sieve and a minimum of 75 percent passing through **No. 60 (0.25-mm)** sieve.
 - 2. Class: O, with a minimum of 95 percent passing through **No. 8 (2.36-mm)** sieve and a minimum of 55 percent passing through **No. 60 (0.25-mm)** sieve.
 - 3. Provide lime in form of ground [**dolomitic limestone**] [**calcitic limestone**] [**mollusk shells**] **<Insert material>**.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through **No. 6 (3.35-mm)** sieve and a maximum of 10 percent passing through **No. 40 (0.425-mm)** sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through **No. 50 (0.30-mm)** sieve.
- G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
- H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.7 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through [1-inch (25-mm)] [3/4-inch (19-mm)] [1/2-inch (12.5-mm)] sieve; soluble salt content of [5 to 10] <Insert range or value> decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: [50 to 60] <Insert range> percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of [0.15 lb/cu. ft. (2.4 kg/cu. m)] <Insert rate> of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of [0.25 lb/cu. ft. (4 kg/cu. m)] <Insert rate> of loose sawdust or ground bark.
- E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.8 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of [1] [4] percent nitrogen and [10] [20] percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.9 PLANTING SOILS

- A. Planting Soil **<Insert drawing designation>**: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of [2] [4] [6] **<Insert number>** percent organic material content; free of stones **1 inch (25 mm)** or larger in any dimension and other extraneous materials harmful to plant growth. Mix ASTM D 5268 topsoil with the following soil amendments[**and fertilizers**] in the following quantities to produce planting soil:
1. Ratio of Loose Compost to Topsoil by Volume: [1:4] [1:3] [1:2] **<Insert ratio>**.
 2. Ratio of Loose [Sphagnum] [Muck] Peat to Topsoil by Volume: **<Insert ratio>**.
 3. Ratio of Loose Wood Derivatives to Topsoil by Volume: **<Insert ratio>**.
 4. Weight of Lime per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 5. Weight of [Sulfur] [Iron Sulfate] [Aluminum Sulfate] per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 6. Weight of Agricultural Gypsum per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 7. Volume of Sand Plus 10 Percent [Diatomaceous Earth] [Zeolites] per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert volume>**.
 8. Weight of Bonemeal per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 9. Weight of Superphosphate per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 10. Weight of Commercial Fertilizer per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 11. Weight of Slow-Release Fertilizer per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
- B. Planting Soil **<Insert drawing designation>**: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process[**and stockpiled on-site**]. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
1. Supplement with [another specified] **<Insert drawing designation>** planting soil when quantities are insufficient.
 2. Mix existing, native surface topsoil with the following soil amendments[**and fertilizers**] in the following quantities to produce planting soil:
 - a. Ratio of Loose Compost to Topsoil by Volume: [1:4] [1:3] [1:2] **<Insert ratio>**.
 - b. Ratio of Loose [Sphagnum] [Muck] Peat to Topsoil by Volume: **<Insert ratio>**.
 - c. Ratio of Loose Wood Derivatives to Topsoil by Volume: **<Insert ratio>**.
 - d. Weight of Lime per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 - e. Weight of [Sulfur] [Iron Sulfate] [Aluminum Sulfate] per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 - f. Weight of Agricultural Gypsum per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 - g. Volume of Sand Plus 10 Percent [Diatomaceous Earth] [Zeolites] per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert volume>**.
 - h. Weight of Bonemeal per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 - i. Weight of Superphosphate per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 - j. Weight of Commercial Fertilizer per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
 - k. Weight of Slow-Release Fertilizer per **1000 Sq. Ft. (92.9 Sq. m)**: **<Insert weight>**.
- C. Planting Soil **<Insert drawing designation>**: Existing, in-place surface soil. Verify suitability of existing surface soil to produce viable planting soil. Remove stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix surface soil with

the following soil amendments[**and fertilizers**] in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Surface Soil by Volume: [1:4] [1:3] [1:2] <Insert ratio>.
 2. Ratio of Loose [Sphagnum] [Muck] Peat to Surface Soil by Volume: <Insert ratio>.
 3. Ratio of Loose Wood Derivatives to Surface Soil by Volume: <Insert ratio>.
 4. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 5. Weight of [Sulfur] [Iron Sulfate] [Aluminum Sulfate] per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 6. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 7. Volume of Sand Plus 10 Percent [Diatomaceous Earth] [Zeolites] per 1000 Sq. Ft. (92.9 Sq. m): <Insert volume>.
 8. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 9. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 10. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 11. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
- D. Planting Soil <Insert drawing designation>: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from [agricultural land,]bogs or marshes.
1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch (25 mm) or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.
 2. Mix imported topsoil or manufactured topsoil with the following soil amendments[**and fertilizers**] in the following quantities to produce planting soil:
 - a. Ratio of Loose Compost to Topsoil by Volume: [1:4] [1:3] [1:2] <Insert ratio>.
 - b. Ratio of Loose [Sphagnum] [Muck] Peat to Topsoil by Volume: <Insert ratio>.
 - c. Ratio of Loose Wood Derivatives to Topsoil by Volume: <Insert ratio>.
 - d. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - e. Weight of [Sulfur] [Iron Sulfate] [Aluminum Sulfate] per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - f. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - g. Volume of Sand Plus 10 Percent [Diatomaceous Earth] [Zeolites] per 1000 Sq. Ft. (92.9 Sq. m): <Insert volume>.
 - h. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - i. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - j. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - k. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
- E. Lightweight On-Structure Planting Soil <Insert drawing designation>: Mix produced by modifying planting soil as follows:

1. Planting Soil <Insert drawing designation>: [One] <Insert number> part(s), except replace [all] [half] <Insert amount> of sand content with perlite.
2. Additional Perlite: [One] <Insert number> part(s).
3. Additional [Sphagnum] [Muck] Peat: [One] <Insert number> part(s).
4. Additional Lime: Ground [dolomitic limestone] [calcitic limestone] [mollusk shells] <Insert material> applied at the rate of [3 lb per cu. yd. (1.36 kg per cu. m)] <Insert rate>.
5. <Insert material and quantity>.

2.10 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.
- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of [2 to 5] <Insert range or value> decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 1. Organic Matter Content: [50 to 60] <Insert range> percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.11 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.12 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, **6 inches (150 mm)** long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of **0.92 lb/sq. yd. (0.5 kg/sq. m)**, with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, **6 inches (150 mm)** long.
- C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of **[3-inch (75-mm)] [4-inch (100-mm)] [6-inch (150-mm)]** <Insert dimension> nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
- Invisible Structures, Inc.; Slopetame 2.
 - Presto Products Company, a business of Alcoa; Geoweb.
 - Tenax Corporation - USA; Tenweb.
 - <Insert manufacturer's name; product name or designation>.

2.13 GRASS-PAVING MATERIALS

- A. Grass Paving: Cellular, non-biodegradable plastic mats, designed to contain small areas of soil and enhance the ability of turf to support vehicular and pedestrian traffic, of **[1-inch (25-mm)] [1-3/4-inch (45-mm)] [2-inch (50-mm)] [manufacturer's standard]** <Insert dimension> nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
- Grid Technologies, Inc.; Netlon 50.
 - Invisible Structures, Inc.; Grasspave2.
 - NDS, Inc.; **[Tufftrack] [Grassroad Paver8 Plus]**.
 - Presto Products Company, a business of Alcoa; Geoblock Porous Pavement System.
 - RK Manufacturing, Inc.; Grassy Pavers.
 - <Insert manufacturer's name; product name or designation>.
- B. Base Course: Sound crushed stone or gravel complying with **[ASTM D 448 for Size No. 8] [Division 31 Section "Earth Moving" for base-course material]** <Insert requirements>.
- C. Sand: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
- D. Proprietary Growing Mix: As submitted and acceptable to Architect.

- E. Sandy Loam Soil Mix: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate blended with planting soil <Insert drawing designation> as specified. Use blend consisting of [1/2 sand and 1/2 planting soil] [2/3 sand and 1/3 planting soil] <Insert proportions>.
- F. Soil for Paving Fill: Planting soil <Insert drawing designation> as specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of [4 inches (100 mm)] [6 inches (150 mm)] [8 inches (200 mm)] <Insert depth>. Remove stones larger than [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert size> in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply [superphosphate] <Insert type> fertilizer directly to subgrade before loosening.
 2. [Thoroughly blend planting soil off-site before spreading] [or] [spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil].
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 3. Spread planting soil to a depth of [4 inches (100 mm)] [6 inches (150 mm)] [8 inches (200 mm)] <Insert depth> but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top [2 inches (50 mm)] [4 inches (100 mm)] of subgrade. Spread remainder of planting soil.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 2. Loosen surface soil to a depth of at least [6 inches (150 mm)] [8 inches (200 mm)]. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top [4 inches (100 mm)] [6 inches (150 mm)] of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Apply [superphosphate] <Insert type> fertilizer directly to surface soil before loosening.
 3. Remove stones larger than [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] in any dimension and sticks, roots, trash, and other extraneous matter.
 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- 3.4 PREPARATION FOR EROSION-CONTROL MATERIALS
- A. Prepare area as specified in "Turf Area Preparation" Article.
 - B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 PREPARATION FOR GRASS-PAVING MATERIALS

- A. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus **1/2 inch (13 mm)** of finish elevation. Roll and rake, remove ridges, and fill depressions.
- B. Install **[base course] [and] [sand course]** and **[sandy loam soil mix] [proprietary growing mix] [soil for paving fill]** as recommended by paving-material manufacturer for site conditions; comply with details shown on Drawings. Compact according to paving-material manufacturer's written instructions.
- C. Install paving mat and fasten according to paving-material manufacturer's written instructions.
- D. Before planting, fill cells of paving mat with **[planting soil] [sandy loam soil mix] [proprietary growing mix] [sand half full]** and compact according to manufacturer's written instructions.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.6 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds **5 mph (8 km/h)**. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of **[2 lb/1000 sq. ft. (0.9 kg/92.9 sq. m)] [3 to 4 lb/1000 sq. ft. (1.4 to 1.8 kg/92.9 sq. m)] [5 to 8 lb/1000 sq. ft. (2.3 to 3.6 kg/92.9 sq. m)] <Insert rate>**.
- C. Rake seed lightly into top **1/8 inch (3 mm)** of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding **[1:4 with erosion-control blankets] [and] [1:6 with erosion-control fiber mesh]** installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of [2 tons/acre (42 kg/92.9 sq. m)] <Insert rate> to form a continuous blanket [1-1/2 inches (38 mm)] <Insert thickness> in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 2. Bond straw mulch by spraying with asphalt emulsion at a rate of [10 to 13 gal./1000 sq. ft. (38 to 49 L/92.9 sq. m)] <Insert rate>. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying [compost mulch] [peat mulch] [planting soil] within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of [3/16 inch (4.8 mm)] <Insert thickness>, and roll surface smooth.

3.7 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
1. Mix slurry with [nonasphaltic] [asphalt-emulsion] [fiber-mulch manufacturer's recommended] tackifier.
 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than [1500-lb/acre (15.6-kg/92.9 sq. m)] <Insert rate> dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
 3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than [500-lb/acre (5.2-kg/92.9 sq. m)] <Insert rate> dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of [1000 lb/acre (10.4 kg/92.9 sq. m)] <Insert rate>.

3.8 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
1. Lay sod across angle of slopes exceeding 1:3.
 2. Anchor sod on slopes exceeding 1:6 with wood pegs [or steel staples] spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of **1-1/2 inches (38 mm)** below sod.

3.9 PLUGGING

- A. Plant plugs in holes or furrows, spaced [**12 inches (300 mm)**] [**18 inches (450 mm)**] <Insert spacing> apart in both directions. On slopes, contour furrows to near level.

3.10 SPRIGGING

- A. Plant freshly shredded sod sprigs in furrows [**1 to 1-1/2 inches (25 to 38 mm)**] [**1-1/2 to 2 inches (38 to 50 mm)**] [**2-1/2 to 3 inches (64 to 75 mm)**] deep. Place individual sprigs with roots and portions of stem in moistened soil, [**6 inches (150 mm)**] [**12 inches (300 mm)**] <Insert spacing> apart in rows [**10 inches (250 mm)**] [**18 inches (450 mm)**] <Insert spacing> apart, and fill furrows without covering growing tips. Lightly roll and firm soil around sprigs after planting.
- B. Broadcast sprigs uniformly over prepared surface at a rate of [**10 cu. ft./1000 sq. ft. (0.28 cu. m/92.9 sq. m)**] <Insert rate> and mechanically force sprigs into lightly moistened soil.
 - 1. Spread a **1/4-inch- (6-mm-)** thick layer of [**compost mulch**] [**peat mulch**] [**planting soil**] on sprigs.
 - 2. Lightly roll and firm soil around sprigs after planting.
 - 3. Water sprigs immediately after planting and keep moist by frequent watering until well rooted.

3.11 TURF RENOVATION

- A. Renovate existing turf.
- B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 - 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 - 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of **6 inches (150 mm)**.
- I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top **4 inches (100 mm)** of existing soil. Install new planting soil to fill low spots and meet finish grades.
- J. Apply [**seed and protect with straw mulch**] [**sod**] as required for new turf.
- K. Water newly planted areas and keep moist until new turf is established.

3.12 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of **4 inches (100 mm)**.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of **1 inch (25 mm)** per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow [**bentgrass**] <Insert grass species> to a height of **1/2 inch (13 mm)** or less.
 - 2. Mow [**bermudagrass**] <Insert grass species> to a height of **1/2 to 1 inch (13 to 25 mm)**.
 - 3. Mow [**carpetgrass**] [**centipedegrass**] [**perennial ryegrass**] [**zoysiagrass**] <Insert grass species> to a height of **1 to 2 inches (25 to 50 mm)**.
 - 4. Mow [**Kentucky bluegrass**] [**buffalograss**] [**annual ryegrass**] [**chewings red fescue**] <Insert grass species> to a height of **1-1/2 to 2 inches (38 to 50 mm)**.
 - 5. Mow [**bahiagrass**] [**turf-type tall fescue**] [**St. Augustinegrass**] <Insert grass species> to a height o **2 to 3 inches (50 to 75 mm)**.
- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that will provide actual nitrogen of at least [**1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m)**] <Insert rate> to turf area.

3.13 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding **[90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm)]** <Insert coverage>.
 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
 3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
 4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.14 MEADOW

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds **5 mph (8 km/h)**. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow seed at a total rate of **[4 oz./1000 sq. ft. (113 g/92.9 sq. m)] [5 oz./1000 sq. ft. (142 g/92.9 sq. m)] [6 oz./1000 sq. ft. (170 g/92.9 sq. m)]** <Insert rate>.
- C. Brush seed into top **1/16 inch (1.6 mm)** of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas from hot, dry weather or drying winds by applying **[peat] [or] [compost]** mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of **3/16 inch (4.8 mm)**, and roll surface smooth.
- E. Water newly planted areas and keep moist until meadow is established.

3.15 MEADOW MAINTENANCE

- A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.
 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water meadow with fine spray at a minimum rate of **1/2 inch (13 mm)** per week for **[four] [six] [eight]** weeks after planting unless rainfall precipitation is adequate.

3.16 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.17 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

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 the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Mechanical sleeve seals.
 - 3. Sleeves.
 - 4. Escutcheons.
 - 5. Grout.
 - 6. Fire-suppression equipment and piping demolition.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Painting and finishing.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber

1.4 CODES AND STANDARDS

A. All work tests and products shall conform to the latest editions of the following codes and in accordance to the following authorities:

1. NFPA 1, 13, 14, 20, 24, 25, 70, 72, 101, 230, 2001 and any other related sections.

Note: Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears. Applicable material and installation standards referenced in Appendix "A" of NFPA 13 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, the more stringent requirement shall apply. All requirements found in these specifications that exceed the minimum NFPA requirements shall be incorporated into the design.

2. State Building Code
3. State Fire Safety Code
4. U.L., F.M., A.S.T.M., and A.N.S.I.
5. Authorities Having Jurisdiction (Fire Marshal's office and/or Local Fire Prevention Inspection Bureau.
6. Insurance Underwriter's Office

1.5 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

- A. Before submitting prices, thoroughly examine the contract documents with special emphasis on all the adjoining work upon which the system installation depends.
- B. No claim for extra compensation will be recognized for difficulties encountered which, in the opinion of the Architect, would have been revealed by the proper examination of the contract documents.

1.6 DESIGN INTENT

- A. General: Work shall be in accordance with the arrangement, details, and locations as indicated on the contract drawings, and supplemental addenda, or drawings issued by the Architect. Layouts are diagrammatic, and final arrangement of equipment shall suit conditions. The drawings are not intended to be sealed, but shall be followed with sufficient accuracy to coordinate completely with other trades. Work installed in a manner contrary to that shown on the drawings, or interfering with the work of another trade, shall be removed and reinstalled without any additional expense to the Owner when so directed by the Architect.
- B. Bidding Responsibility: The contract drawings and specifications are meant to provide a complete system; any piping, sprinkler heads and appurtenances found to be necessary shall be noted as such by the Contractor to the Architect prior to submission of bid. This shall include the contractor contacting the Insurance Agency during the bid process and receiving design criteria from them, especially Factory Mutual Insurance Company. Fire protection contractors bid shall be based on the Insurance Company design criteria. All equipment shall be Factory Mutual approved without exception.

- C. Coordination of Trades: This Contractor shall refer to the sprinkler drawings, architectural drawings, structural drawings, electrical and site drawings and details and all other drawings in the contract set for a full comprehension of the extent and detail of work to be performed. These drawings are intended to be supplementary to the specification, but any work indicated, mentioned or implied in either is to be considered as specified by both. It is not intended that the drawings show every pipe, fitting and appliance, but this Contractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best practice of the trades and to the satisfaction of the Architect.
- D. Performance Criteria: The engineer has developed general performance criteria for the sprinkler systems. The contractor shall be responsible for hiring a qualified engineer, registered to practice in this state, or a registered Fire Protection Engineer, as per the local authority, to prepare and be responsible for the final design of the sprinkler systems. The final design of the sprinkler systems, and any calculations, shall be submitted to the engineer for review and comment. The Engineers review of the contractors engineers design shall not, in any manner, relieve the contractor of full responsibility for the final design of the sprinkler systems.

Design Criteria:

1. Light Hazard
Light Hazard design criteria shall be as follows:
Density: 0.10 gpm per square foot over 1,500 sq. ft.
Maximum spacing per sprinkler: 225 sq. ft. (non-combustible/non-obstructed)
Hose stream: 100 gpm.
2. Ordinary Hazard
Ordinary Hazard Group 1 design criteria shall be as follows:
Density: 0.15 gpm per square foot over 1,500 sq. ft.
Maximum spacing per sprinkler: 130 sq. ft. (non-combustible/non-obstructed)
Hose stream: 250 gpm
3. Ordinary Hazard Group 2 design criteria shall be as follows:
Density: 0.18 gpm per square foot over 2,000 sq. ft.
Maximum spacing per sprinkler: 130 sq. ft. (non-combustible/non-obstructed)
Hose stream: 250 gpm

1.7 SPRINKLER STAGING

- A. Provide staging, riggings and lifts for all work under this section.

1.8 SUBMITTALS

- A. Product Data: For the following:
1. Mechanical sleeve seals.
 2. Escutcheons.
- B. Welding certificates.

1.9 QUALITY ASSURANCE

- A. The entire fire protection system shall be furnished, fabricated, installed and tested by an approved Fire Protection Contractor. Sprinklers and equipment shall be as manufactured by one of the following, or only as further specified in these documents.
1. Tyco Fire Suppression & Building Products
 2. Victaulic Company
 3. The Viking Corporation
 4. Reliable Sprinkler Co.
- B. Sprinkler contractor shall be a certified installer and shall have been in the sprinkler business for more than five (5) years.
- C. Architectural Considerations: The contractor shall obtain approval of the architect for all mounting and support details and locations. This contractor shall pay the costs to repair any damage done by his installing crews.
- D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- E. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- F. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.10 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 plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.11 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. 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 thickness or specific material is 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.
 2. AWWA C110, rubber, flat face, **1/8 inch** thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - e. Approved equal.
 2. Sealing Elements: **[EPDM] [NBR] <Insert other>** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Plastic, **Carbon steel or Stainless steel**. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Carbon **steel with corrosion-resistant coating or Stainless steel** of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.
- 2.7 GROUT
- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 FIRE-SUPPRESSION DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

- B. 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.
- 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 to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
 - l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Existing Piping: Use the following:

- a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - g. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
 - h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
 - i. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
 - j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
 - k. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- 1. 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 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.4 PAINTING

- A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.5 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 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 the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.8 GROUTING

- A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 210500

SECTION 21 10 00 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

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 the following fire-suppression piping inside the building:
 - 1. Automatic Wet-pipe sprinkler systems.
- B. Related Sections include the following:
 - 1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
 - 2. Division 22 Section "Facility Water Distribution Piping" for piping outside the building.
 - 3. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride plastic.
- B. CR: Chlorosulfonated polyethylene synthetic rubber.
- C. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.
- D. PE: Polyethylene plastic.
- E. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
 - 2. Pipe hangers and supports, including seismic restraints.
 - 3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
 - 4. Air compressors, including electrical data.
 - 5. Excess-pressure pumps, including electrical data.
 - 6. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.

7. Hose connections, including size, type, and finish.
 8. Hose stations, including size, type, and finish of hose connections; type and length of fire hoses; finish of fire hose couplings; type, material, and finish of nozzles; and finish of rack.
 9. Roof hose cabinets.
 10. Monitors.
 11. Fire hydrants.
 12. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
 13. Alarm devices, including electrical data.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Fire-hydrant flow test report.
- D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13, NFPA 14 and NFPA 25. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Welding certificates.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.
- 1.6 QUALITY ASSURANCE
- A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13, "Installation of Sprinkler Systems."
 2. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
 3. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
 4. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
 5. NFPA 25 "Standard For The Inspection, Testing And Maintenance Of Water – Based Fire Protection Systems".
 6. NFPA 230, "Fire Protection of Storage."

1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 RECORD DRAWINGS

- A. The contractor shall keep daily updated accurate records of all deviations in work as actually installed from work indicated on the contract drawings. Each Contractor shall record clearly, neatly, accurately, and promptly as work progresses the following data:
 - 1. Changes made resulting from change orders or instructions or sketches issued by the A/E.
 - 2. Changes in routing made to avoid conflict with other trades or structural conditions.
 - 3. Final location of equipment and panels if different than contract documents.
- B. The record drawings shall be kept at the job site, available to the owner at all times and labeled as "Project Record Information – Job Set". When work is completed, one complete set of marked-up original prints, updated CADD drawings with all changes listed above and a CD with CADD files shall be delivered to the A/E for approval.
- C. All CADD files requested by the Contractor will be given to the contractor at a cost of \$200.00 per drawing/sheet.

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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, 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 on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile-iron gland, rubber gasket, and steel bolts and nuts.

- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.
1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
- C. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Tyco Fire Suppression & Building Products
 - 2) Victaulic Co. of America.
 - 3) The Viking Corporation
 - b. Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.
 - c. Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, prelubricated rubber gasket with center leg, and steel bolts and nuts.
 - d. Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with end matching ductile-iron-pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
 - e. Grooved-End Transition Flange: UL 213, gasketed fitting with key for ductile-iron-pipe dimensions. Include flange-type, ductile-iron housing with rubber gasket listed for use with housing and steel bolts and nuts.

2.3 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
 5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
- B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products

- 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
- C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- D. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, square-cut-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- E. Threaded-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795 or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe; hot-dip galvanized where indicated and with factory- or field-threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
 5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.
- F. Plain-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795; or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe hot-dip galvanized where indicated.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation

- 5) Ward Manufacturing.
 - 6) (Approved Equal)
- G. Plain-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795, or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe hot-dip galvanized where indicated.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- H. Grooved-End, Schedule 40 Steel Pipe: ASTM A 135 or ASTM A 795, or ASTM A 795 and ASME B36.10M, Schedule 40 wrought-steel pipe hot-dip galvanized where indicated; with factory- or field-formed, roll-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- I. Threaded-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe.
 5. Steel Threaded Couplings: ASTM A 865.
- J. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)

- K. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- L. Grooved-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed, roll-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- M. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½" and greater; and NFPA 13-specified wall thickness in NPS 6 to NPS 10.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
- N. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½" and greater; and NFPA 13 specified wall thickness in NPS 6 to NPS 10.
1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- O. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 2 ½" and greater; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.
1. Grooved-Joint Piping Systems:

- a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America.
 - 4) The Viking Corporation
 - 5) Ward Manufacturing.
 - 6) (Approved Equal)
- b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
- c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves rubber gasket listed for use with housing, and steel bolts and nuts.

2.4 CPVC PIPE AND FITTINGS

- A. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig rated pressure at 150 deg F, with plain ends. Include "Listed" and "CPVC Sprinkler Pipe" markings.
 1. CPVC Fittings: UL-listed, for 175-psig rated pressure at 150 deg F, socket type. Include "Listed" and "CPVC Sprinkler Fitting" markings.
 - a. NPS 3/4 to NPS 1-1/2: ASTM F 438 and UL 1821, Schedule 40.
 - b. NPS 2 to NPS 3: ASTM F 439 and UL 1821, Schedule 80.
 2. Adhesive: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by manufacturer of pipe and fittings.
 3. CPVC fire sprinkler system components shall only be permitted for use in:
 - a. Light Hazard Occupancies as defined by NFPA 13 2002 Edition.
 - b. Ordinary hazard rooms of otherwise light hazard occupancies where the room does not exceed 400 sq. ft., per section 6.3.6.2 of NFPA 13, 2002 Edition.
 - c. Air handling (plenum) spaces as defined by NFPA 90A.
 - d. Exposed conditions and unfinished basements in accordance with the manufacturer's Design and Installation Manual.
 - e. Combustible Concealed Spaces in accordance with the manufacturer's design and Installation Manual and applicable Specific Application Sprinkler datasheets.
 4. Manufacturers
 - a. Tyco Fire Suppression & Building Products
 - b. Victaulic
 - c. The Viking Corporation
 - d. (Approved Equal)

2.5 DIELECTRIC FITTINGS

- A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

- B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.
1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Hart Industries International, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Industries, Inc.; Wilkins Div.
 - e. (Approved Equal)
- C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.
1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. (Approved Equal)
- D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.
1. Manufacturers:
 - a. Advance Products and Systems, Inc.
 - b. Calpico, Inc.
 - c. Pipeline Seal and Insulator, Inc.
 - d. (Approved Equal)
- E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.
1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
 - c. (Approved Equal)
- F. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 225 deg F.
1. Manufacturers:
 - a. Perfection Corporation.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Co. of America.
 - d. (Approved Equal)

2.6 FLEXIBLE CONNECTORS

- A. Flexible connectors shall have materials suitable for system fluid. Include 250-psig minimum working-pressure rating and ends according to the following:

1. NPS 2 and Smaller: Threaded.
2. NPS 2-1/2 and Larger: Flanged.
3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.

B. Manufacturers:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Tyco Fire Suppression & Building Products.
4. Victaulic
5. The Viking Corporation.
6. (Approved Equal)

C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.7 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.8 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

B. Outlet Specialty Fittings:

1. Manufacturers:

- a. Anvil International, Inc.
- b. Tyco Fire Suppression & Building Products
- c. Victaulic Co. of America.
- d. The Viking Corporation
- e. Ward Manufacturing.
- f. (Approved Equal)

2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.

3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:

- a. Tyco Fire Suppression & Building Products
 - b. Viking Corp.
 - c. Victaulic Co. of America.
 - d. (Approved Equal)
- D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
- 1. Manufacturers:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Potter-Roemer; Fire-Protection Div.
 - c. (Approved Equal)
- E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
- 1. Manufacturers:
 - a. AGF Manufacturing Co.
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Co. of America.
 - d. The Viking Corporation
 - e. (Approved Equal)
- F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
- 1. Manufacturers:
 - a. Tyco Fire Suppression & Building Products
 - b. Victaulic Co. of America
 - c. (Approved Equal)
- G. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.9 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
- B. Gate Valves with Wall Indicator Posts:
- 1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
 - 2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
 - 3. Manufacturers:
 - a. NIBCO.
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Co. or America
 - d. The Viking Corporation
 - e. (Approved Equal)
- C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 3. NPS 3: Ductile-iron body with grooved ends.
 4. Manufacturers:
 - a. NIBCO.
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Co. of America.
 - d. The Viking Corp.
 - e. (Approved Equal)
- D. Butterfly Valves: UL 1091.
1. NPS 2 and Smaller: Bronze body with threaded ends.
 - a. Manufacturers:
 - 1) NIBCO.
 - 2) Tyco Fire Suppression & Building Products.
 - 3) Victaulic Co. of America
 - 4) The Viking Corporation
 - 5) (Approved Equal)
 2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
 - a. Manufacturers:
 - 1) NIBCO.
 - 2) Tyco Fire Suppression & Building Products.
 - 3) Victaulic Co. of America
 - 4) The Viking Corporation
 - 5) (Approved Equal)
- E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
 - a. NIBCO.
 - b. Tyco Fire Suppression & Building Products.
 - c. Victaulic Co. of America.
 - d. The Viking Corp.
 - e. (Approved Equal)
- F. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.
 - a. Manufacturers:
 - 1) NIBCO.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America
 - 4) The Viking Corporation
 - 5) (Approved Equal)

2. **NPS 2-1/2** and Larger: Cast-iron body with flanged ends.
 - a. Manufacturers:
 - 1) NIBCO.
 - 2) Tyco Fire Suppression & Building Products
 - 3) Victaulic Co. of America
 - 4) The Viking Corporation
 - 5) (Approved Equal)

2.10 UNLISTED GENERAL-DUTY VALVES

- A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
- B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
- C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
- D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.11 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum pressure rating if sprinklers are components of high-pressure piping system.
- B. Manufacturers:
 1. Reliable Automatic Sprinkler Co., Inc.
 2. Tyco Fire Suppression & Building Products
 3. Victaulic Co. of America.
 4. Viking Corp.
 5. (Approved Equal)
- C. Automatic Sprinklers: Quick (fast) Response With heat-responsive glass bulb element complying with the following:
 1. UL 199, for nonresidential applications.
 2. UL 1626, for residential applications.
 3. UL 1767, for early-suppression, fast-response applications.
- D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
 1. Open Sprinklers: UL 199, without heat-responsive element.
 - a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
 - b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.
- E. Sprinkler types, features, and options as follows:
 1. Concealed ceiling sprinklers, including cover plate.
 2. Extended-coverage sprinklers.

3. Flow-control sprinklers, with automatic open and shutoff feature.
 4. Flush ceiling sprinklers, including escutcheon.
 5. High-pressure sprinklers.
 6. Institution sprinklers, made with a small, breakaway projection.
 7. Open sprinklers.
 8. Pendent sprinklers.
 9. Pendent, dry-type sprinklers.
 10. Quick-response sprinklers.
 11. Recessed sprinklers, including escutcheon.
 12. Sidewall sprinklers, Vertical and Horizontal Type Sprinklers.
 13. Sidewall, dry-type sprinklers.
 14. Upright sprinklers.
 15. Window – wash Vertical Pendent Sprinklers.
- F. Sprinkler Finishes: Chrome plated, bronze, and painted. (Coordinate colors with Architect).
- G. Special Coatings: Wax, lead, and corrosion-resistant paint.
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat Plastic, white finish, one piece, flat].
 2. Sidewall Mounting Plastic, white finish, one piece, flat.
- I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.
- 2.12 ALARM DEVICES
- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.
1. Manufacturers:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire Suppression & Building Products
 - c. Victaulic Co. of America
 - d. Viking Corp.
 - e. (Approved Equal)
- C. Electrically Operated Alarm: UL 464, with 6-inch- minimum diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. (Approved Equal)
- D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include 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.

1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. Tyco Fire Suppression & Building Products
 - d. Viking Corp.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. (Approved Equal)

- E. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. Tyco Fire Suppression & Building Products
 - d. Viking Corp.
 - e. (Approved Equal)

- F. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. Tyco Fire Suppression & Building Products
 - d. (Approved Equal)

- G. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
 - c. Tyco Fire Suppression & Building Products
 - d. (Approved Equal)

2.13 PRESSURE GAGES

- A. Manufacturers:

1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.
5. (Approved Equal)

- B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING APPLICATIONS, GENERAL

- A. Shop weld pipe joints where welded piping is indicated.
- B. Do not use welded joints for galvanized-steel pipe.
- C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded end joints.
- E. Underground Service-Entrance Piping: Ductile-iron, mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.
- F. Underground Service-Entrance Piping: Ductile-iron, grooved-end pipe and fittings; grooved-end-pipe couplings; and grooved joints. Include corrosion-protective encasement.
- G. Underground Service-Entrance Piping: Type K, soft copper tube; wrought-copper fittings; and brazed joints. Include corrosion-protective encasement.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
 - 1. Sprinkler-Piping Fitting Option: Specialty sprinkler fittings, NPS 2 and smaller, including mechanical-T and -cross fittings, may be used downstream from sprinkler zone valves.
 - 2. Copper-Tube Fitting Option: Copper, mechanically formed tee branches NPS 2 and smaller, with brazed joints, may be used downstream from sprinkler zone valves.

- Comply with schedule tube and branch sizes listed in UL's "Fire Protection Equipment Directory."
3. NPS 1-1/2 and Smaller: Threaded-end, black, Schedule 40 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 4. NPS 1-1/2 and Smaller: Plain-end, black, Schedule 40 steel pipe; locking-lug fittings; and twist-locked joints.
 5. NPS 1-1/2 and Smaller: Plain-end, black, Schedule 40 steel pipe; steel welding fittings; and welded joints.
 6. NPS 1-1/2 and Smaller: Plain-end, Type L, hard copper tube; wrought-copper fittings; and brazed joints.
 7. NPS 1-1/2 and Smaller: SDR 13.5, CPVC pipe; Schedule 40, CPVC fittings; and solvent-cemented joints.
 8. NPS 2: Threaded-end, black, Schedule 40 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 9. NPS 2: Plain-end, black, Schedule 40 steel pipe; locking-lug fittings; and twist-locked joints.
 10. NPS 2: Plain-end, black, Schedule 40 steel pipe; steel welding fittings; and welded joints.
 11. NPS 2: Grooved-end, black, Schedule 40 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 12. NPS 2: Plain-end, Type L, hard copper tube; wrought-copper fittings; and brazed joints.
 13. NPS 2: SDR 13.5, CPVC pipe; Schedule 80, CPVC fittings; and solvent-cemented joints.
 14. NPS 2-1/2 to NPS 3-1/2: Plain-end, black, Schedule 10 steel pipe; steel welding fittings; and welded joints.
 15. NPS 2-1/2 to NPS 3-1/2: Grooved-end, black, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 16. NPS 2-1/2 to NPS 3-1/2: Threaded-end, threadable, thinwall steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 17. NPS 2-1/2 to NPS 3-1/2: Plain-end, threadable, thinwall steel pipe; steel welding fittings; and welded joints.
 18. NPS 2-1/2 to NPS 3-1/2: Grooved-end, threadable, thinwall steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 19. NPS 2-1/2 and NPS 3: Plain-end, Type K, hard copper tube; wrought-copper fittings; and brazed joints.
 20. NPS 2-1/2 and NPS 3: SDR 13.5, CPVC pipe; Schedule 80, CPVC fittings; and solvent-cemented joints.
 21. NPS 4 to NPS 6: Plain-end, black, Schedule 10 steel pipe; steel welding fittings; and welded joints.
 22. NPS 4 to NPS 6: Grooved-end, black, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 23. NPS 4 to NPS 6: Threaded-end, threadable, thinwall steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 24. NPS 4 to NPS 6: Plain-end, threadable, thinwall steel pipe; steel welding fittings; and welded joints.
 25. NPS 4 to NPS 6: Grooved-end, threadable, thinwall steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.6 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 14.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves.
 - b. Throttling Duty: Use ball or globe valves.

3.7 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Twist-Locked Joints: Insert plain-end piping into locking-lug fitting and rotate retainer lug one-quarter turn.
- D. Pressure-Sealed Joints: Use UL-listed tool and procedure. Include use of specific equipment, pressure-sealing tool, and accessories.
- E. Mechanically Formed, Copper-Tube-Outlet Joints: Use UL-listed tool and procedure. Drill pilot hole in copper tube, form branch for collar, dimple tube to form seating stop, and braze branch tube into formed-collar outlet.
- F. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
 1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
 2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
 3. Copper Tube: Roll-groove tubing. Use grooved-end fittings and grooved-end-tube couplings.
 4. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.
- G. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
 1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
 2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
 3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.8 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
- B. 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.

- C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints. Encase piping in corrosion-protective encasement.
- D. Install underground copper service-entrance piping according to NFPA 24. Encase piping in corrosion-protective encasement.
- E. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- F. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- G. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- H. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- I. Install sprinkler piping with drains for complete system drainage.
- J. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- K. Install drain valves on standpipes.
- L. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- M. Install alarm devices in piping systems.
- N. Hangers and Supports: Comply with NFPA 13 for hanger materials.
 - 1. Install standpipe system piping according to NFPA 14.
 - 2. Install sprinkler system piping according to NFPA 13.
- O. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- P. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- Q. Drain dry-type standpipe piping.
- R. Drain dry-pipe sprinkler piping.
- S. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices.
- T. Fill wet-standpipe system piping with water.
- U. Fill wet-pipe sprinkler system piping with water.
- V. Install flexible connectors on fire-pump and pressure-maintenance-pump supply and discharge connections and in fire-suppression piping where indicated.

3.9 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 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. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.
- D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
- E. Specialty Valves:
 - 1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.
 - 2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - a. Air-Pressure Maintenance Devices for Dry-Pipe Systems: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
 - b. Install air compressor and compressed-air supply piping.
 - c. Install compressed-air supply piping from building's compressed-air piping system.
 - 3. Deluge Valves: Install in vertical position, in proper direction of flow, in main supply to deluge system.

3.10 SPRINKLER APPLICATIONS

- A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers, as indicated.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated. Listed for dry use.
 - 5. Deluge-Sprinkler Systems: Upright and pendent, open sprinklers.
 - 6. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
 - 7. Sprinkler Finishes:
 - a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated 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.
 - b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - c. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - d. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 - e. Residential Sprinklers: Dull chrome.

3.11 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles, both ways.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.12 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Connect excess-pressure pumps to the following piping and wiring:
 - 1. Sprinkler system, hydraulically.
 - 2. Pressure gages and controls, hydraulically.
 - 3. Electrical power system.
 - 4. Alarm device accessories for pump.
 - 5. Fire alarm.
- G. Connect compressed-air supply to dry-pipe sprinkler piping.
- H. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire alarm devices, including low-pressure alarm.
- I. Electrical Connections: Power wiring is specified in Division 26.
- J. Connect alarm devices to fire alarm.
- K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- M. 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 and UL 486B.

3.13 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 .

3.14 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 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.
 - 3. Energize circuits to electrical equipment and devices.
 - 4. Start and run excess-pressure pumps.
 - 5. Start and run air compressors.
 - 6. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 7. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
 - 8. Coordinate with fire alarm tests. Operate as required.
 - 9. Coordinate with fire-pump tests. Operate as required.
 - 10. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.15 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

3.16 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Alignment guides and anchors.
2. Sleeves without waterstop.
3. Grout.
4. Silicone sealants.
5. Escutcheons.

1.2 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.
 - a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
 - b. Include operating characteristics and furnished accessories.

- B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

C. Silicone Sealants:

2.2 ESCUTCHEONS

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. BrassCraft Manufacturing Co.; a Masco company
2. Jones Stephens Corp.
3. Mid-America Fittings, LLC; A Midland Industries Company

B. Basis-of-Design Product: Subject to compliance with requirements, provide BrassCraft or comparable product by one of the following:

1. BrassCraft Manufacturing Co.; a Masco company
2. Jones Stephens Corp.
3. Mid-America Fittings, LLC; A Midland Industries Company

C. Escutcheon Types:

1. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed, and, exposed-rivet hinge; and spring-clip fasteners.

- D. Floor Plates:
 - 1. Split Floor Plates: Cast brass with concealed hinge.

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 expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- B. Install rubber packless expansion joints in accordance with 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 one 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 SLEEVES - GENERAL

- 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 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.
- 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 joint sealants that joint sealant manufacturer's literature indicates is 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."

3.6 INSTALLATION OF ESCUTCHEONS

- 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.

3.7 FIELD QUALITY CONTROL

- A. Sleeves and Sleeve Seals:
 - 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
 - 2. Prepare test and inspection reports.
- B. Escutcheons:
 - 1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.8 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above and below Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 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. Sleeves with waterstops.
 4. Interior Wall and Partitions:
 - a. Sleeves without waterstops.

3.9 ESCUTCHEONS APPLICATION

- A. Escutcheons for New Piping and Relocated Existing Piping:
1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 2. Chrome-Plated Piping: One piece, steel with polished, chrome-plated finish.
 3. Insulated Piping:
 - a. One piece, steel with **[polished, chrome-plated][polished brass]** finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated finish.
 - d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated finish.
 - d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 5. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated finish.
 - d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with polished, chrome-plated finish.
 - c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 7. Bare Piping in Equipment Rooms:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with **[polished, chrome-plated][rough-brass]** finish.
 - c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- B. Escutcheons for Existing Piping to Remain:
1. Chrome-Plated Piping: Split casting, stamped steel with concealed hinge with polished, chrome-plated finish.
 2. Insulated Piping: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish
 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 6. Bare Piping in Equipment Rooms: Split plate, stamped steel with concealed hinge 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.
 2. Existing Piping: Split floor plate.

END OF SECTION

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes Cx process requirements for the following plumbing systems, assemblies, and equipment:
 - 1. Sanitary waste and vent piping.
 - 2. Storm drainage piping.
 - 3. Plumbing equipment.
- 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. IAPMO: International Association of Plumbing and Mechanical Officials.
- D. IgCC: International Green Construction Code.
- E. "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:
 - 1. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to plumbing to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements", IAPMO "Green Plumbing and Mechanical Code Supplement," and ASHRAE 202.
- C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, 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 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 Cx PROCESS

- A. Perform Cx process for plumbing systems in accordance with:
1. 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 plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in ASHRAE 202. Contractor performs the following:
1. Review plumbing preliminary construction checklists and provide written comments on Construction 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)." 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 plumbing 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)." 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. 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. Meters and gauges.
 - g. General-duty and specialty valves.
 - h. Hangers and supports.

- i. Heat tracing.
 - j. Vibration isolation and seismic restraints.
2. 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. Tubs, drain connections, and faucets.
 - f. Showers, supplies, drain connections, and faucets.
 - g. Wash fountains, supplies, drain connections, and faucets.
 - h. Emergency plumbing fixtures, supplies, drain connections, and controls.
 - i. Drinking fountains, supplies, and drainage connections.

3.3 Cx TESTING PREPARATION

- A. Certify that plumbing 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 plumbing system 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 that all systems are set to and maintaining set points as required by the design documents.
- C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with 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 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 compared 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 test 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. Cx Construction Checklist verification tests.
 - 2. Cx Construction Checklist verification test demonstrations.

END OF SECTION 220800

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.2 ACTION SUBMITTALS

A. Product Data:

1. PVC pipe and fittings.

B. Sustainable Design Submittals:

C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 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.

1.4 FIELD 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 in accordance with requirements indicated:

1. Notify Architect 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 Architect's written permission.

1.5 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
 1. Soil, Waste, and Vent Piping: 10 ft. head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation 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 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 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. 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.

2.3 PVC PIPE AND 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. Apollo Valves; a part of Aalberts Integrated Piping Systems
 2. Charlotte Pipe and Foundry Company
 3. North America Pipe Corporation
- B. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.
- C. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
- D. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.
- E. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- F. Adhesive Primer: ASTM F656.
 1. Adhesive primer shall have a VOC content of 550 g/L or less.
 2. Adhesive primer 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."

3. Adhesive primer 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." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
4. Adhesive primer 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." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

G. Solvent Cement: ASTM D2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. 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 220548.13 "Vibration 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.
 - 1. 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.
 - 2. 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.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste 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 and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: Two 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 Sanitary Waste Piping: Two percent downward in direction of flow.
 - 3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- O. Install steel piping in accordance with applicable plumbing code.
- P. Install stainless steel piping in accordance with ASME A112.3.1 and applicable plumbing code.
- Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."
- R. Install aboveground ABS piping in accordance with ASTM D2661.
- S. Install aboveground PVC piping in accordance with ASTM D2665.
- T. Install underground PVC piping in accordance with ASTM D2321.
- U. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- V. Install underground, ductile-iron, force-main piping according to AWWA C600.
1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- W. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."
1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.
- X. Install force mains at elevations indicated.
- Y. Plumbing Specialties:
1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- AA. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
- BB. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."
- CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for escutcheons specified in Section 220500 "Common Work

Results for Plumbing."

3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.
 - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- E. Join stainless steel pipe and fittings with gaskets in accordance with ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. 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.
- I. 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. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
 - 3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.
- J. Joint Restraints and Sway Bracing:
 - 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater

than two pipe sizes.

- b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
- c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 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. 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. Install individual, straight, horizontal piping runs:
 - a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52 spring hangers.
- C. Install hangers for PVC 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 of each fitting, valve, and coupling.
- E. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste

- Piping Specialties."
6. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main.
 2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections in accordance with 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.
- 3.6 IDENTIFICATION
- A. Identify exposed sanitary waste and vent piping.
 - B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
- 3.7 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.
 - 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.
 - 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.
- E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 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. Exposed Plastic Piping: Protect PVC plumbing vents exposed to sunlight with two coats of water-based latex paint.

- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 (DN 100) is to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Air-admittance valves.
4. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
2. Section 221323 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.

1.2 DEFINITIONS

A. 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. Plastic Floor Cleanouts (Insert drawing designation, if any):

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. IPS Corporation
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Zurn Industries, LLC
2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

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. Sleeve Flashing Device :

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

C. Expansion Joints :

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

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 sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- F. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- G. Install wood-blocking reinforcement for wall-mounting-type specialties.
- H. 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

SECTION 221329 - SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible effluent pumps.
2. Sewage-pump basins and basin covers.

B. Related Requirements:

1. Section 221429 "Sump Pumps" for applications in storm-drainage systems.
2. Section 333200 "Site Packaged Sewage Pumping Stations" for applications in site-construction sewage pumping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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. 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.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 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 manufacturer's written instructions for handling.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.2 SUBMERSIBLE EFFLUENT PUMPS

- A. Submersible, Fixed-Position, Single-Seal Effluent Pumps:
 - 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. GRUNDFOS CBS Inc.
 - b. Liberty Pumps
 - 2. Description: Factory-assembled and -tested effluent-pump unit.
 - 3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
 - 4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 - 5. Impeller: Statically and dynamically balanced, ASTM A48/A48M, Class No. 25 A cast iron, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
 - 6. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
 - 7. Seal: Mechanical.
 - 8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Oil.
 - 9. Controls, Rod-and-Float Type:
 - a. Enclosure: NEMA 250, Type 1.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
 - 10. Controls, Float- and Pressure-Switch Type:
 - a. Enclosure: NEMA 250, Type 1; **[pedestal][wall]** mounted.
 - b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120 V ac,

with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

- a. Remote Alarm Contacts: For remote alarm interface.
- b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.

B. Capacities and Characteristics:

1. Unit Capacity: 50 gpm.
2. Number of Pumps: One.
3. Each Pump:
 - a. Capacity: 50 gpm.
 - b. Solids Handling Capability: Not applicable.
 - c. Total Dynamic Head: 35feet.
 - d. Speed: 3450.
 - e. Discharge Pipe Size: 1-1/2" NPS.
 - f. Motor Horsepower: 1/2 hp.
 - g. Electrical Characteristics:
 - 1) Volts: 120 V ac.
 - 2) Phases: Single.
 - 3) Hertz: 60.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.3 INSTALLATION

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.
2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

B. Equipment Mounting:

1. Install progressing-cavity sewage pumps 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 vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

- C. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 1. Perform each 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.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 221329

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and General Provisions of Contract, including General and Modifications to General Conditions and Division 1 Specification Sections, apply to work specified in this Section.
- B. Equality of materials, articles, assembly or systems, other than those named or described in this Section, will be determined in accordance with the provisions given to Substitutions.
- C. All work in this Section is subject to the codes and standards of this Section unless otherwise listed in Section 230548 "Vibration and Seismic Controls", which will take precedence.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Inserts.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Concrete bases.
 - 9. Supports and anchorages.
 - 10. Flashing of curbs.
 - 11. Openings in walls.
 - 12. Cutting and patching
 - 13. Painting.
 - 14. Electrical wiring.
 - 15. Vibration Isolation and seismic controls.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and within chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. "Contractor" means specifically sub-contractor working under his respective Section of the Specifications.
- G. "Furnish" and "Provide" mean to supply, erect, install and connect up complete in readiness for regular operation, particular work referred to, unless otherwise specified.
- H. "Piping" includes, in addition to pipe, all fittings, valves, hangers and other accessories relating to such piping.
- I. "Ductwork" includes, in addition to ducts, all fittings, hangers, dampers, elbows, transitions, access panels, breaker strips, flexible connections and other accessories relating to ductwork.
- J. "Supply" means purchase and delivery of material to the site.
- K. "Install" means to erect in place the supplied item.

1.4 SUBMITTALS

- A. Submit color samples for pipe coding system.
- B. Submit copies for approval and record of:
 - 1. All Tests.
 - 2. Balancing Report.
 - 3. Valve Chart.
 - 4. Pipe Color Code Chart.
 - 5. Maintenance Manuals.
 - 6. All products and materials supplied under Division 23.
- C. Any additional cost or loss, or damage arising from the substitution of any material or method for those originally specified shall be borne by the Contractor, notwithstanding review or acceptance of such substitution by the Owner or the Architect, unless the substitution was made at the written request of the Owner. Any cost for re-design of any components of the contract documents shall be borne by the Contractor, unless the substitution was made at the written request of the Owner.
- D. Submittals shall be used by the contractor to coordinate location and size of access requirements, and location of piping, duct, drain, and electrical connections. Where the submittal is lacking proper information, the contractor shall obtain certified drawings or manufacturers installation brochures and instructions for the equipment before proceeding with the work.

1.5 SUBSTITUTIONS

- A. Requests for substitutions shall be submitted in writing two (2) weeks prior to bid opening. Otherwise, substitutions will only be considered when a product becomes unavailable through no fault of the Contractor.

- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- C. A request constitutes a representation that the Contractor:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality and operating efficiency level of the specified product.
 - 2. Has investigated proposed product and determined that it meets or exceeds the performance and has lower sound power ratings than the specified product.
 - 3. Has investigated proposed product and determined that it physically fits in the space designed, and does not require extensive revision of structural framing.
 - 4. Will provide the same warranty for the Substitution as for the specified product.
 - 5. Will coordinate installation and make changes to other Work which may be required for the Work to be complete in all respects with no additional cost to Owner.
 - 6. Waives claims for additional costs or time extension which may subsequently become apparent.
 - 7. Will reimburse Owner for review or re-design services associated with re-approval by authorities.
- D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require revision to the Contract Documents.
- E. Engineer will determine acceptability of proposed substitution and will notify Contractor of acceptance or rejection in writing within a reasonable time.
- F. The Mechanical Contractor shall be responsible for the cost of and coordination of electrical revisions required as a result of the use of substituted equipment including modification to wire size, breaker size, wire routing, or starter/disconnect accessory differences.
- G. Only one request for substitution will be considered for each product. When substitution is not accepted, provide the specified product. If a substitution is submitted and rejected more than one time, the Engineer reserves the right to bill the Mechanical Contractor for additional review hours at the hourly rate established in the AIA Contract.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified with no additional cost to the owner. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- D. Piping shall be fabricated by a qualified licensed plumber/pipefitter and/or steamfitters.
- E. Drainage piping shall be installed by a qualified drain layer.

1.7 SCOPE OF WORK

- A. Provide all labor, materials, equipment, controls and accessories necessary to complete the work shown on the Drawings or herein specified to provide complete and operable systems.
- B. The work to be done under this Division includes all related work shown on the Drawings and or included in these Specifications.
- C. Provide commissioning of all mechanical systems; the general contractor as well as all sub-contractors shall cooperate with the commissioning agent and provide all required information to aid in system commissioning. Commissioning does not replace any specified start-up and testing of major pieces of equipment owned by the Mechanical Contractor.
- D. Drawings are diagrammatic and all duct and pipe fittings, transitions, or offsets required for installation in the actual space are not necessarily shown. Changes in duct size, shape, and route must be coordinated and approved prior to fabrication or installation.

1.8 MATERIALS

- A. Any device, material or construction required to complete the job that is not specifically covered by description herein shall be of commercial-grade material normally used for the purpose and installed in a manner consistent with the conditions of use. Items exposed to the elements shall be weatherproofed or protected. All such items shall be submitted for review before being purchased or installed.

1.9 CODES AND STANDARDS

- A. Materials and equipment shall be designed, constructed, installed and tested in accordance with this Specification and the latest editions of the following applicable standards in addition to state and local codes applying. All products shall bear the label of approval from the appropriate agency.

Agencies:

National Environmental System Contractors Assoc.	NESCA
Air Moving and Conditioning Association	AMCA
American Society of Heating, Refrigerating and Air Conditioning Engineers	ASHRAE
American Society of Mechanical Engineers	ASME
Federal Construction Safety Standards (U.S. Dept. of Labor)	FCSS
American Society of Testing Materials	ASTM
National Electric Code	NEC
National Electrical Manufacturers Association	NEMA
National Fire Code	NFC
Occupational Safety and Health Act of '70	OSHA
International Building Code (Latest Edition)	IBC
National Sanitation Foundation	NSF
Air Conditioning and Refrigeration Inst.	ARI
Underwriters Laboratories, Inc.	UL
Building Officials & Code Administrators International, Inc.	BOCA
International Code Council	ICC
National Fire Protection Association	NFPA
Sheet Metal and Air Conditioning Contractors National Association	SMACNA
American National Standards Institute	ANSI
American Welding Society	AWS
Cast Iron Soil Pipe Institute	CISPI
Clean Air Act Amendment of 1990 (Title VI. Section 608)	CAA
Cooling Tower Institute	CTI

International Mechanical Code

IMC

- B. Any materials or workmanship called for in the requirements of the above-mentioned standards which are not specified or shown on the Drawings, shall be furnished and installed by the Contractors as though same had been specifically mentioned or indicated.
- C. If these Contractors fail to notify the A/E at this time, and install work in variance with the above-mentioned codes and regulations, they shall assume responsibility and expense to rectify the installation to the satisfaction of the A/E and Owner.
- D. Secure all local, state and federal permits necessary in connection with the installation of the equipment, including licenses and approvals and pay fees required for same.
- E. All work shall be performed in strict accordance with the above-mentioned standards, local and state codes.
- F. File all necessary Plans and Documents with Local Authorities and obtain the necessary Certificates of Inspection for work. Deliver same to A/E prior to request for acceptance and final payment.
- G. Notify A/E of any deviation from codes of work indicated or herein specified before installation of work is affected.

1.10 WORK PROCEDURE

- A. The Contractor shall, in good workmanlike manner, perform all work and furnish all supplies and materials, machinery, equipment, refrigerant charges, water treatment, equipment support structures including those for VFD/Starter, hoisting, rigging, and means, herein and otherwise specified, necessary or proper to perform and complete all work required by the Plans and Specifications in order to have a complete and satisfactory installation acceptable to the A/E.

1.11 DELIVERY, STORAGE, HANDLING AND PROTECTION

- A. Prior to installation, and after installation, follow Sections in Division 1.
- B. During construction, close open ends of work subject to weather or adverse conditions with temporary covers or plugs to prevent entry of water, dirt and obstructing materials.

1.12 COOPERATION WITH OTHER TRADES / COORDINATION DRAWINGS

- A. Cooperate to fullest extent with all other trades to best expedite the entire work.
- B. Furnish all information pertaining to materials, sizes, locations, means of support, etc., to all other trades requiring such information.
- C. Where work of Contractor will be installed in close proximity to work of other trades, or where there is evidence that work of Contractor will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustment.
- D. Contractor shall prepare composite working "COORDINATION" drawings and sections at suitable scale not less than $\frac{1}{4}" = 1'-0"$ clearly showing how his work is to be installed in relation to work of other trades. The contractor shall identify any conflicts, investigate and suggest possible resolutions, and request assistance from the Architect / Engineer for assistance in resolving a field

condition in order to complete the work required. No additional compensation will be granted or awarded for resolving coordination issues since this is considered part of this contractor's duties. Coordination drawings for suggested resolution of coordination issues shall be produced by this contractor and submitted for review by the Engineer.

1.12 GUARANTEE

- A. The system specified herein and shown on the drawings shall be guaranteed to be free from original defects in both material and workmanship and shall perform to manufacturer specification for a period of **two (2) years** of normal use and service, excepting damages from other causes. Systems which are manufactured ISO-9001 certification are preferred. This guarantee shall become effective starting the date the Contract work is accepted as complete by the Architect on behalf of the Owner and in accordance with the General Provisions/Conditions.
- B. Upon completion of the installation, this contractor shall submit to the owner a proposal for a standard maintenance agreement to support the system operation for one year beyond the warranty period. This service should include an option for manufacturer's recommended service maintenance for equipment as well as 24-hour emergency response
- C. Upon completion of the installation, the ATC Subcontractor shall submit to the Owner an agreement to provide the necessary programmed maintenance, to keep the various control systems in proper working condition **for one year** beyond the guarantee period. Additionally, this contractor shall submit to the owner its standard agreement to support the system operation. This service must include operators support, application support, remote diagnostic support as well as database management support. This service shall be available 365 days/year, 24 hours a day.
- D. This programmed maintenance agreement shall fully describe the maintenance work to be performed and shall advise as to the cost of this work prior to awarding of Contract.

1.14 RECORD DRAWINGS

- A. The contractor shall keep daily updated accurate records of all deviations in work as actually installed from work indicated on the contract drawings. Each Contractor shall record clearly, neatly, accurately, and promptly as work progresses the following data:
 - 1. Changes made resulting from change orders or instructions or sketches issued by the A/E.
 - 2. Changes in routing made to avoid conflict with other trades or structural conditions.
 - 3. Final location of equipment and panels if different than contract documents.
- B. The record drawings shall be kept at the job site, available to the Owner at all times and labeled as "Project Record Information – Job Set". When work is completed, one complete set of marked-up original prints, updated Cad drawings with all changes listed above and a CD with Cad files shall be delivered to the A/E for approval.

PART 2- PRODUCTS

2.1 GENERAL

- A. All products shall be new and without defects.

- B. Products required by construction but not specifically described herein shall be as selected by the Contractor subject to the approval of the A/E.
- C. All products of Section 230548 Vibration and Seismic Controls shall take preference over the products of this Section.
- D. All products shall be of an approved type and shall be designed for the pressures and temperatures at which they are to be operated, for the materials they are to handle and for their intended use.

2.2 DUCTWORK

- A. Refer to individual Division 23 Ductwork Sections for duct materials, accessories, and installation methods.
- B. Where ductwork penetrates any smoke and/or fire rated partitions provide UL listed dynamic fire and/or smoke dampers per NFPA Guidelines. Install dampers per manufacturer's instructions and install a duct and architectural access panels for every damper as required to test, inspect, and reset.
- C. Provide duct access doors for all motorized dampers, air flow stations, fire & smoke dampers, duct smoke detectors, the entering side of every coil, and at all other locations where components are installed within ductwork regardless of whether or not an access is indicated on the floor plans.
- D. All changes in duct direction shall be made in solid ductwork, not flexible duct.
- E. Square-throat/round-heel elbows are not allowed.
- F. Seal and pressure test ductwork as required in Section 233113 Metal Ducts.

2.3 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.4 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- D. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.5 SLEEVES

- A. Through outside masonry walls and below grade masonry walls, use schedule 40 ductile iron, caulked watertight.
- B. Through masonry floors or interior masonry walls and fire rated assemblies, use Schedule 40 galvanized steel pipe.
- C. Through interior non-fire rated stud partitions, use 22-gauge galvanized sheet metal.
- D. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- E. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- F. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- H. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- I. PVC Pipe: ASTM D 1785, Schedule 40.
- J. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. Escutcheons for pipes passing through outside walls shall be solid cast brass, flat type, secured to pipe with a set screw, Ritter Pattern & Casting Co., #1.
- B. Escutcheons for pipes passing through floors shall be split hinged, cast brass type designed to fit pipe on one end and cover sleeve projection through floor on other end, Ritter Pattern & Casting Company, #36A.
- C. Escutcheons for pipes passing through interior walls, partitions and ceilings shall be split-hinged, cast brass, chromium plated type, Ritter Pattern & Casting Co., #3A.
- D. Beaton & Corbin and/or Caldwell products will be acceptable.

2.7 INSERTS

- A. Inserts shall be individual or strip type, of pressed steel construction galvanized only with accommodation for removable nuts and threaded rods up to $\frac{3}{4}$ " diameter, permitting lateral adjustment. Individual inserts shall have an opening at top to allow reinforcing rods up to $\frac{1}{2}$ " diameter to be passed through insert body and shall be Fee & Mason Manufacturing Company, Figure 178. Strip inserts shall have attached rods with hooked ends to allow fastening to reinforcing rods and shall be Fee & Mason Manufacturing Company, Figure 190. Grinnell or Carpenter Patterson materials will be acceptable.

- B. At Contractor's option, inserts may be galvanized, malleable iron, Universal type, Grinnell, Figure 279, for pipe sized up to 3½", Figure 282, for all sizes up to 8".
- C. Where subject to corrosive atmospheres use stainless steel products.

2.8 ACCESS DOORS

- A. The contractor shall furnish access panels not smaller than 12 x 16" for access to concealed valves, traps, dampers, sensors, etc. where no other means of access is provided. Access panels shall be all steel construction with no. 16 gauge wall or ceiling and no. 14 gauge panel door with not less than 1/8" insulation secured to inside of the door. Doors shall be supported with concealed hinges and secured with suitable clips and countersunk flush screws. Outside of access panels shall be flush with finished wall or ceilings, except that where panels are located in acoustic tile or paneling, the door shall be recessed to receive adjacent finish material. The final position for each access door and the size to be used shall be determined by the contractor. Access panels shall be as manufactured by MILCOR. Fire ratings of access door shall not be less than the surface on which the door is installed.

PART 3- EXECUTION

3.1 GENERAL

- A. All installation methods of Section 230548 "Vibration and Seismic Controls" shall take precedence over the methods of this Section.

3.2 INTERPRETATION OF DRAWINGS

- A. Mechanical equipment and such other apparatus as may require maintenance and operation from time to time shall be made easily accessible. Although the equipment may be shown on the Drawings in certain locations, the construction may disclose that such locations do not make its position readily accessible. In such cases, the Owner or his Representative shall be notified before advancing the construction to a stage where a change will reflect additional expense.
- B. Compare actual site conditions with the Drawings and Specifications and include additional work which careful examination would disclose. Before the bidding period, advise the A/E of any omission, error or conflict in the Plans and Specifications.
- C. Equipment, ductwork and piping locations, as shown, are diagrammatic and approximate only unless fixed by dimensions. As the drawings are diagrammatic, every fitting, transition, and offset required for the installation is not shown on the drawings, but shall be anticipated to be necessary for the installation by the contractor. Actual field conditions and physical characteristics of the product govern exact locations. Where possible, adhere to locations on Drawing consistent with building construction and equipment installed by others.
- D. Contractor shall not scale measurements from the Drawings but check with General Contractor's latest Drawings, shop drawings, and equipment manufacturer's installation guides before proceeding with any work.
- E. Work layouts shall be the responsibility of the Contractor, following minimum requirements as set forth in these Specifications and accompanying Drawings.
- F. Where head room or space conditions appear inadequate, A/E shall be notified before proceeding with installation. If directed by A/E, Contractor shall, without extra charge, make reasonable

modifications in layout as needed to prevent conflicts with work of other trades or for proper execution of work.

- G. If, in Contractor's opinion, work is shown or specified in manner or amount as to make it impossible to install a top quality piece of work or fulfilling intent of a perfectly efficient job when complete, refer same to A/E in writing before submitting proposals. The contractor shall suggest options for solutions to conflicts for review by the engineer.
- H. Should Contractor fail to refer such instances to A/E as required above, no excuse for poor, defective or incomplete work will be accepted.

3.3 SHOP DRAWINGS

- A. All equipment shall be submitted for approval under these Sections to the A/E.
- B. Do not place orders for any equipment until final approval is received. Allow at least two weeks for submittal review.
- C. If material or equipment is installed before it is approved, Contractor shall be liable for removal and replacement at no extra charge to the Owner.
- D. Contractor shall consult manufacturer's installation brochures and instructions to determine exact location of connection points. Take special care to allow for proper space for maintenance, operation of valves, removal of coils, filters and equipment. Provide offset pipe and union/flange arrangements for ease of removal of coils and equipment. Provide accessories required or recommended by the manufacturer. Locate drains for proper pitch and trapping for coils, space for control valves, and other components. Coordinate with electrical contractor by advising of proper location of attachment of electrical devices to be clear of areas of maintenance or access.
- E. Shop drawings shall be submitted on all major pieces of equipment and material. Each item of equipment proposed shall be a standard catalog product of an established manufacturer. The shop drawing shall give complete information on the proposed equipment such as: capacity, size, construction, material, dimensions, arrangement, operating clearances, performance characteristics, weight and rating authority. Each item of the shop drawing shall be properly labeled, indicating the intended service of the material.
- F. The contractor shall, before submitting the shop drawings of the equipment to the A/E, check each item of the shop drawings to verify the proper equipment is included. Items to check shall include but not be limited to confirmation that the equipment will physically fit into space; proper equipment for the job; electrical characteristics including operating efficiencies and voltage matches that of electric service; proper arrangements for connections; that the equipment meets code requirements, and that all required BMS/DDC components are included.
- G. The shop drawings shall be submitted electronically to the A/E with a letter of transmittal, which shall list each item, submitted with the manufacturer's name.
- H. Review of the shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings have been reviewed, said review does not mean that drawings have been checked in detail; said review does not in any way relieve the contractor from his responsibility or the necessity of furnishing material or performing work as required by the contract drawings.

3.4 WARRANTY

- A. Refer to General Conditions. The warranty period for the work under this Section is for TWO years from date of acceptance. These contractors shall provide free day-and-night service, parts and labor for the complete installation of the entire system for this period.

3.5 CONTRACTOR'S RESPONSIBILITY

- A. Contractor shall be held responsible for any injuries to people, employees or damage done to building premises or adjoining areas or to other work resulting from execution on his part of work, in any manner whatsoever.
- B. Contractor shall be responsible for proper protection of his work, materials, people or employees from injury or loss done by others and shall make good such injury at his own expense.
- C. The Engineer shall not be responsible for the safety of Contractor's employees.
- D. The contractor shall be responsible for coordination with the electrical contractor with regard to final diffuser & smoke detector installation. Smoke detectors should not be located in a direct air-flow or closer than 1 m (3 ft) from an air supply diffuser or return air opening. Supply or return sources larger than those commonly found in residential and small commercial establishments can require greater clearance to smoke detectors. Similarly, smoke detectors should be located farther away from high velocity air supplies.

3.6 CUTTING AND PATCHING

- A. All rough cutting and patching required for installation of the mechanical system shall be the responsibility of this contractor. All finish patching relative to this contractor's work shall be the responsibility of other trades in accordance with other sections of this specification. Coordinate all work for a complete and finished installation.
- B. Contractor shall furnish sketches showing the locations and sizes of all openings and chases, and furnish and locate all sleeves and inserts required for the installation of the mechanical work before the walls, floors and roof are built. The contractor shall be responsible for the cost of cutting and patching where any mechanical items were not installed or where incorrectly sized or located. The contractor shall do all drilling required for the installation of his hangers.

3.7 TESTING

- A. Refer to sections 230800 "Commissioning of HVAC", 019113 "General Commissioning Requirements", and 230593 "Testing, Adjusting and Balancing for HVAC" for the requirements of coordination, verification, and reporting of tests.
- B. Contractor shall submit to the A/E for record and approval a written report for each test conducted including manufacturer's equipment start-up testing. Report shall indicate date of test, system tested, method of testing, name of person or agency witnessing test, and results of tests. If test records are not kept and submitted, it will be assumed that the test was not completed and Contractor will be required to perform the test at A/E 's direction.
- C. All piping, ducts and equipment shall be tested. Contractor shall furnish Labor, materials, instruments and power required for testing unless otherwise indicated under particular section of Specifications.

- D. Tests shall be scheduled in advance, and shall be performed in presence of and to satisfaction of A/E, Commissioning Agent, Owner's Representative and/or such other parties as may have jurisdiction.
- E. Pressure test shall be applied to piping and ductwork only before connection of equipment. In no case shall piping, equipment or accessories be subjected to pressures exceeding their ratings.
- F. Provisions for capping and sealing ductwork and piping in preparation of testing, and restoring for final connection to equipment is the responsibility of this contractor.
- G. Ductwork shall be tested in accordance with SMACNA HVAC Duct Leakage Test Manual, with a minimum test of 25% of all ducts operating in excess of 3" wc total static pressure on fans, all ducts installed outdoors, all ducts that will be concealed within shafts, solid ceiling, crawl spaces, or solid soffits in the finished condition. In no case shall the maximum leakage allowed be equal to or greater than the SMACNA permitted leakage rates. Ductwork shall be resealed, sealant allowed to cure, and retested until all mains and all sections outdoors and within concealed ceilings, soffits, shafts and chases meets the leakage requirements.
- H. Defective work shall be promptly repaired or replaced and tests shall be repeated until particular system and/or component parts receive approval of the A/E.
- I. Any damages resulting from tests shall be repaired and damaged materials replaced.
- J. Duration and style of tests shall be as determined by authorities having jurisdiction or Commissioning Agent directive, but in no case less than time prescribed in each Section of Specifications. In general, pressure for tests shall be 1.5 times working pressure unless prescribed otherwise by code, specific specification section or ASTM Guidelines.
- K. Equipment and systems which normally operate during certain seasons of year shall be tested during appropriate season. Test shall be performed on individual equipment, systems and their controls for proper operation, functioning and performance. Controls shall be operated simultaneously with equipment of system being tested.
- L. During testing procedure, remove accessories liable to damage during tests.
- M. Notice shall be furnished to A/E at least two days prior to any testing. Contractor shall be solely responsible for any delays, damages, etc., resulting from failure to notify.
- N. Instruments required under this Contract for permanent installation may be used for testing if re-adjusted and recalibrated for the service for which intended.

3.8 CLEANING OF SYSTEM

- A. All piping, ducts and equipment shall be thoroughly cleaned of foreign matter after being placed in operation. System shall be disconnected, cleaned and reconnected wherever necessary to locate and remove obstructions. Any work damaged in course of removing obstructions shall be repaired or replaced when system is reconnected at no additional cost to the Owner.
- B. Replace all air filters with new prior to balancing of air systems.

3.9 SLEEVES, INSERTS, ANCHOR BOLTS

- A. Sleeves shall be located by this Contractor and set by the General Contractor, subject to A/E approval. Provide General Contractor with such information in ample time to prevent unnecessary cutting and patching. Mechanical Contractor shall be responsible for and subsequent cutting and patching of openings if sleeves have been omitted due to failure of setting them properly or in time. Fasten sleeves securely to avoid dislocation during concrete pouring.
- B. In placing sleeves, inserts, anchor bolts or any other material to be embedded in masonry and concrete or built into structure, Contractor shall cooperate with all other trades and shall consult with A/E in regard to their exact locations wherever there is any interference with structural members.
- C. Contractor will be held responsible for location of and maintaining in proper positions, sleeves, inserts and anchor bolts supplied and/or set in place by him. In event that failure to do so requires cutting and patching of finished work, it shall be done at Contractor's expense.
- D. All pipes and conduits passing through floors, walls or partitions shall be provided with sleeves having an internal diameter two inches larger than outside diameter of pipe.
- E. Sleeves through outside walls shall be painted with one coat of bitumastic paint inside and outside. Sleeves shall extend ½" beyond each side of wall. Space between sleeve and pipe shall be packed with oakum to within two inches of each face of wall. Remaining space shall be packed and made watertight with a waterproof compound.
- F. Sleeves through masonry floors or interior masonry walls shall be set flush with finished wall or ceiling surfaces.
- G. Sleeves through interior stud partitions shall be set flush with finished surfaces of partitions.

3.10 ESCUTCHEONS

- A. Escutcheons shall be installed on pipes wherever they pass through floors, ceilings, wall partitions and outside walls where exposed to view.

3.11 OPERATING INSTRUCTIONS

A. Operation of system - Instruction:

- 1. Contractor is responsible for construction and installation of all mechanical systems and shall supply the services of competent personnel for a period of one day per system (heating, cooling, controls) plus one day per major piece of equipment (VRF heat pumps, ERVs, air cooled condensers) to instruct owner's personal. As such, Contractor may be required during the first year to review every phase of all mechanical systems with Owner's personnel and also to instruct and supervise Owner's personnel in the proper operation and maintenance of said system. Time shall be recorded by Contractor and signed by Owner or Representative. At the owner's request, the training instruction shall be video recorded and shall be included in the Operating Manual package.

B. Operation of system - Manuals:

- 1. Contractor shall provide complete operating instructions of all systems installed, provided as electronic documents in MS Word or Adobe PDF format. Manuals shall be labeled with job name, address and date. Information on each piece of equipment of system shall be in a separate tab labeled section. Provide a complete index of the contents. After approval by the Engineer the zip files shall be forwarded to the Owner.

2. Manual shall contain one approved copy of each shop drawing and submitted data, printed instructions as to care and maintenance of system arranged in the following sequence:
 - a. Table of Contents
 - b. Description of Installation with Contractor contact information and letter of Warranty including start date and terms.
 - c. Care and Maintenance: Including a check and follow-up chart for greasing and oiling of all mechanical equipment and a copy of instructions as to upkeep of motors.
 - d. Manufacturer's Listing: In alphabetical order, of all equipment installed on job, together with a listing of material supplied, manufacturer's address, name and address of local manufacturer's agent.
 - e. Copy of Service Valve Charts
 - f. Copy of Pipe System complete with color samples.
 - g. Testing & Balancing Report
 - h. Duct Pressure Test Report
 - i. Equipment start-up report and records including incident reports and refrigerant charges
 - j. List of filter sizes for all mechanical equipment including "clean filter" pressure drop gauge reading and "change filter" pressure drop gauge reading
 - k. Updated Automatic Temperature Control submittal & sequence of operations
 - l. Operating & Maintenance manuals for the automatic temperature control system
 - m. Manufacturer's Equipment Warranties
 - n. Project documents and certificates
 - o. The manual shall also include a schedule for all equipment maintenance. Schedule shall provide a general outline for equipment requirement. Example; filters shall be changed every 3 months, test dampers once a year

3.12 PROJECT CLOSEOUT AND TROUBLE SHOOTING

- A. Each trade shall designate one person to methodically test, adjust, trouble shoot and effect repairs to all equipment, devices and systems. The person shall be available on one hour's notice to answer trouble calls and to fully investigate and repair the cause of the problem. Each trade shall submit the name and phone number of the designated person to the Owner, Engineer and Architect. After final acceptance, this same person shall be available on eight hour's notice for free day-and-night service during the guarantee period.
- B. Contractor shall demonstrate all sequences of control to the Commissioning Agent and Engineer. The temperature control and balancing sub-contractors shall accompany the Commissioning Agent and Engineer during check-out procedure and shall demonstrate proper balancing positions of minimum fresh-air settings. Personnel shall be equipped with tools and spare parts to make minor repairs and adjustments.
- C. Balanced positions shall be indicated with permanent marker on valves; label filter gauges with "clean filter pressure drop" and "change filter pressure drop".
- D. Contractor shall demonstrate compliance with balancing of systems in the presence of the Engineer by actual measurement of water and air flows at a minimum of three locations randomly selected by the Engineer. If requested by the Engineer, re-balancing shall be done at no additional charge.

3.13 FIRE STOPPING

- A. Each trade is responsible for fire stopping of its own work.
- B. Fire stopping material shall be typical of HILTI Fire Barrier.
- C. Each trade must submit intended fire stopping material and methods for each application with UL listed approved designs.

3.14 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. 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.
- 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 with provisions to permit expansion.
- G. Install piping to permit valve servicing.
- H. Install piping at indicated slopes.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install piping to allow application of insulation. Arrange operable accessories so that the final insulation thickness will not restrict the operation of valve handles or connection of hose fittings on drains.
- L. Select system components with pressure rating equal to or greater than system operating pressure.
- M. Install escutcheons for penetrations of walls, ceilings, and floors.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire/Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.15 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems and approved joining methods for this project.
- B. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. 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.
- G. 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 or flexible, where required, grooved-end-pipe couplings. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide

on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically review the product installation. Only a direct employee of the grooved system manufacturer shall be considered suitable for field service. A distributor's representative is not to be considered qualified for field service. Contractor shall remove and replace any improperly installed products.

- H. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
- I. Press type fittings shall only be allowed with written permission of the A/E or Owner.

3.16 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.17 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC 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.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 230500

SECTION 23 05 29

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. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.

1.2 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 HVAC piping and equipment shall withstand the effects of gravity loads and stresses.
 - 1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.3 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. Pipe Hangers.
 - 2. Trapeze pipe hangers.
 - 3. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. 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.

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.
- 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.

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 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, zinc-coated or stainless 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.

2.4 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 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. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation for use in lightweight concrete or concrete slabs less than 4 inches thick:
 - 1. 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.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. 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.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.

- I. 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.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. 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.
- L. 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. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - 4. 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.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

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. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and 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.

3.4 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: 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.
- C. 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 carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper 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. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 6. 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.
 7. 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.
 8. 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.
 9. 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 not necessary.
- 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.
- 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. 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.
- 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 - 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 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. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 - 3. 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.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Hangers for horizontal lines, except as noted below and in Section 230500 -
- 1. Vibration Isolation and Seismic Restraint, shall be spaced no greater than as follows:

Pipe Size	Rod Diameter	Maximum Spacing	
		Copper	Steel
1/2"	3/8"	5' - 0"	7' - 0"
3/4"	3/8"	5' - 0"	7' - 0"
1"	3/8"	6' - 0"	7' - 0"
1 1/4"	3/8"	7' - 0"	7' - 0"
1 1/2"	3/8"	8' - 0"	9' - 0"
2"	3/8"	8' - 0"	10' - 0"
2 1/2"	1/2"	9' - 0"	11' - 0"
3"	1/2"	10' - 0"	12' - 0"
4" - 5"	5/8"	12' - 0"	14' - 0"
6" - 8"	3/4"	14' - 0"	17' - 0"

- 2. Copper tubing shall be supported with split ring hangers, copperized with supporting rod.
 - 3. Cast iron soil pipe shall be hung one hanger for each pipe length, close to hub.
 - 4. PVC pipe shall be supported no more than 4'-0" on center.
 - 5. Use insulation protection saddles or shields for all insulated cold piping and where hanger is outside the insulation. Secure all saddles and shields to the insulation to prevent slippage or shifting that may cause the shield to fall to the ground. Saddles shall be spot welded to hangers.
- R. Hangers for vertical pipes shall be spaced no greater than as follows:

PIPING MATERIAL	MAX. VERTICAL SPACING
Cast Iron Pipe	15'-0"
Copper Pipe/Tubing	10'-0"
Galvanized Steel Pipe	15'-0"
PVC Pipe	4'-0"
CPVC Pipe/Tubing	3'-0"

END OF SECTION 230529

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Intent

1. All mechanical equipment, piping and ductwork shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
3. It is the intent of the seismic portion of this Specification to keep all mechanical building system components in place during a seismic event when required by local code.
4. All such systems must be installed in strict accordance with seismic codes, component manufacturers' and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.
5. This Specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e., California Title 24; California OSHPD; Canadian Building Codes; or, other requirements).
6. The Contractor shall correct any variance or non-compliance with these Specification requirements in an approved manner.
7. Seismic restraints shall be designed in accordance with seismic force levels as detailed in the State Building Codes.
8. All in-line equipment will be braced independently of the ducts or pipes and in conformance with all applicable building codes.

B. The work in this Section includes, but is not limited to, the following:

1. Vibration isolation for piping, ductwork and equipment.
2. Seismic restraints for all new gas piping.
3. Equipment isolation bases.
5. Seismic restraints for isolated equipment.
6. Seismic restraints for non-isolated equipment.
7. Certification of seismic restraint designs and installation supervision.
8. Certification of seismic attachment of housekeeping pads.
9. All mechanical systems - equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical (equipment not listed is still included in this Specification):

IDU Units	Ductwork	Condensate Piping
Air Distrib. Boxes	Fans (All Types)	Pumps (All Types)
Air Handling Units	Heat Pumps	Rooftop ERVs
Condensing Units	Refrigerant Piping	Units Heaters

C. Definitions

1. Positive Attachment:
 - a. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double-sided beam clamp loaded perpendicular to a beam, or a welded or bolted

connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, electrical conduit, bus duct, or cable trays, or any other equipment are not acceptable on this project as seismic anchor points.

2. Transverse Bracing:
 - a. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.
3. Longitudinal Bracing:
 - a. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

1.2 SUBMITTAL DATA REQUIREMENTS

- A. The manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:

1. Descriptive Data:
 - a. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the Specification.
 - b. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive Drawings.
2. Shop Drawings:
 - a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 - b. Provide all details of suspension and support for ceiling hung equipment.
 - c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
 - d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
3. Seismic Certification and Analysis:
 - a. Calculations shall be based on "G" forces appropriate for the zone in which the building is located.
 - b. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a Registered Professional Engineer with at least five years of seismic design experience, licensed in the State of the job location.
 - c. All restraining devices shall have a pre-approval number from California's OSHPD or some other recognized government agency showing maximum restraint ratings. Pre-approvals based on independent testing are preferred to pre-approvals based on calculations. Where pre-approved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a Registered Professional Engineer with at least five years of seismic design experience and licensed in the State of the job location. Test-

ing and calculations must include shear and tensile loads as well as one test or analysis at 45° to the weakest mode.

- d. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in the State Building Code acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.3 CODE AND STANDARDS REQUIREMENTS

A. Typical Applicable Codes and Standards

1. Applicable State Building Code.
2. Applicable State Mechanical Code.
3. Applicable State Plumbing and Gas Codes.
4. SMACNA
5. NFPA

1.4 MANUFACTURERS' RESPONSIBILITIES

A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:

1. Determine vibration isolation and seismic restraint sizes and locations.
2. Provide vibration isolation and seismic restraints as scheduled or specified.
3. Provide calculations and materials if required for restraint of un-isolated equipment.
4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.5 RELATED WORK

A. Supplementary Support Steel:

1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc., including roof mounted equipment, as required or specified.

B. Attachments:

1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double-sided beam clamps, etc., in accordance with the requirements of the vibration vendor's calculations.

PART 2 - PRODUCTS

2.1 INTENT

- A. All vibration isolators and seismic restraints described in this Section shall be the product of a single manufacturer. Mason Industry's products are the basis of these Specifications; products of other manufacturers are acceptable provided their systems strictly comply with the Specifications and have the approval of the specifying engineer. Submittals and certification sheets shall be in accordance with Section 230500.
- B. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" and/or horizontal permanent deformation greater than 1/4".

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraints:

1. Two layers of ¾" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc. or equal.
2. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" and all-directional seismic capability. The mount shall consist of a ductile iron casting containing two separated-and-opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be Type BR as manufactured by Mason Industries, Inc. or equal.
3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between two steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in three planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge-bearing quality. Bushing assemblies shall be Type PB as manufactured by Mason Industries, Inc. or equal.
4. A one-piece molded bridge bearing neoprene washer/ bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal-to-metal contact. Neoprene bushings shall be Type HG as manufactured by Mason Industries, Inc. or equal.
5. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or ¼" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be Type SLF as manufactured by Mason Industries, Inc. or equal.
6. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of ½" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage pre-approval "R" number from OSHPD in the State of California certifying the maximum certified horizontal and vertical load ratings. Mountings shall be SLR as manufactured by Mason Industries, Inc. or equal.

7. Spring mountings, as in Specification 5, built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of ¼" travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be SSLFH as manufactured by Mason Industries, Inc. or equal.
8. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8". Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician. Air springs shall be Type MT and leveling valves Type LV, as manufactured by Mason Industries, Inc. or equal.
9. Restrained air spring mountings shall have an MT air spring, as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of ½" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc. or equal.
10. Hangers shall consist of rigid steel frames containing minimum 1¼" thick neoprene elements at the top and a steel spring with general characteristics, as in Specification 5, seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side-to-side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be Type 30N, as manufactured by Mason Industries, Inc. or equal.
11. Hangers shall be as described in paragraph 10 above, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be Type PC30N, as manufactured by Mason Industries, Inc. or equal.
12. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc. or equal.

- a. Cables will be wire-core with a minimum breaking strength as shown in the table below. The cable size is for reference only. The actual cable size should be chosen to provide the breaking strength indicated in the table. Use FS = 2.0 when pre-stretched cable is used with end connections that develop the breaking strength of the cables; otherwise, use FS = 5.0.

Minimum Breaking Strength for Cable Braces

Size inches	Breaking Strength FS = 2.0 pounds	Breaking Strength FS = 5.0 pounds
	¼	4,940
3/8	10,980	27,450
½	19,260	48,150

- b. Cable will be zinc-coated to a minimum of 0.4 ounces per square foot or stainless steel per ASTM A304. Tighten cable only to remove slack.
- c. Use either cable or solid bracing for all situations. Do not mix bracing types.
13. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Seismic solid, brace-end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be Type SSB, as manufactured by Mason Industries, Inc. or equal.
- a. Cold-formed angles will conform to the material and identification requirements of the latest *Specifications for the Design of Cold-Formed Steel Structural Members* of the American Iron and Steel Institute with a minimum $F_y = 33$ ksi and a minimum $F_u = 38$ ksi.
- b. The uncoated minimum steel thickness of the cold-formed product as delivered to the job site will not, at any location, be less than 95% of the thickness indicated in the table below. The thickness may be less at bends after cold-forming.

Standard Sheet Metal Gages

Gage	Standard Uncoated Thickness inches	Galvanized Thickness inches

12	0.1046	0.1084
14	0.0747	0.0785
16	0.0598	0.0635

- c. Hot-rolled shapes and plates will conform to ASTM A36. Pipes used as braces will be standard steel pipes (ASTM A120 or A53).

Note: Specifications 12 through 13 apply to trapeze as well as clevis hanger locations. At trapeze anchor locations, piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.

14. Pipe clevis cross-bolt braces are required in all restraint locations. They shall be special purpose, pre-formed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage pre-approval "R" number from OSHPD in the State of California. Clevis cross braces shall be type CCB, as manufactured by Mason Industries, Inc. or equal.
15. All-directional seismic snubbers shall consist of inter-locking steel members restrained by a one-piece-molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of ¼" thick. Rated loadings shall not exceed 1,000 psi. A minimum air gap of 1/8" shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1225, as manufactured by Mason Industries, Inc. or equal.
16. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of ¾" thick. Rated loadings shall not exceed 1,000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more than ¼". Snubbers shall be installed with factory-set clearances. The capacity of the seismic snubber at 3/8" deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to ½" deflection in the X, Y and Z planes. Snubbers shall have an anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be series Z-1011, as manufactured by Mason Industries, Inc. or equal.
17. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder, which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS, as manufactured by Mason Industries, Inc. or equal.
18. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an Evaluation Report Number from the I.C.B.O Evaluation

ation Service, Inc. verifying to its allowable loads. Drill-in female wedge anchors shall be Type SAB, as manufactured by Mason Industries, Inc. or equal.

19. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machine bases may be T or L shaped where space is a problem. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1". Bases shall be type WF, as manufactured by Mason Industries, Inc. or equal.
20. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of ¼" thick. Steel springs shall be laterally stable and rest on ¼" thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs' waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs' waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2" of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit must be solidly fastened to the top floating rail and the lower Z section anchored to the roof structure. Curb shall have anchorage pre-approval "R" from OSHPD in the State of California attesting to the maximum certified horizontal and vertical load ratings. Curb shall be type RSC, as manufactured by Mason Industries, Inc. or equal.
21. Split wall seals consist of two bolted pipe halves with minimum ¾" thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240° F, 10# density fiberglass may be used in lieu of the ponge. Seals shall be type SWS, as manufactured by Mason Industries, Inc. or equal.
22. Bolts will conform to ASTM A307. Bolt holes will be a maximum of 1/16" (1.6 mm) larger than the bolt diameter unless noted otherwise.
23. Expansion anchors will have local-governing-jurisdiction-approved values equal to, or greater than, both the shear and tension capacities listed in the table below. Cast-in-place concrete inserts may replace expansion anchors where the approved loads are equal to, or greater than, the values for the specified expansion anchors.

Minimum Approved Values for Expansion Anchors

Size inches	Shear Capacity pounds	Tension Capacity pounds
3/8	675	615

1/2	1,130	1,040
5/8	1,580	1,535
3/4	2,270	2,020
7/8	5,060	3,705

324. Welding will conform to AWS D1.1 and use either the shielded or submerged arc methods. Attachments to building components may be subject to review by the design professional.

PART 3 - EXECUTION

3.1 GENERAL

- A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.
- C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- D. The Contractor shall not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Coordinate work with other trades to avoid rigid contact with the building.
- F. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the A/E's attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible Contractor's expense.
- G. Bring to the A/E's attention any discrepancies between the Specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible Contractor's expense.
- H. At no additional cost, correct all installations that are deemed defective in workmanship and materials, at the Contractor's expense.
- I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the Structural Engineer of record for approval. Generally, bracing may occur from:
 - 1. Flanges of structural beams.
 - 2. Upper truss cords in bar joist construction.
 - 3. Cast-in-place inserts or wedge-type, drill-in concrete anchors.
- J. All attachments to structural elements will be reviewed with the appropriate design professional.

- K. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- L. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.
- M. At locations where Specifications 12 or 13 restraints are located, the support rods must be braced where necessary to accept compressive loads with Specification 14 braces.
- N. At all locations where Specifications 12 or 13 restraints are attached to pipe clevis', the clevis cross bolt must be reinforced with Specification Type 15 braces.
- O. Drill-in concrete anchors for ceiling and wall installation shall be Specification Type 18 and Specification Type 19 female wedge-type for floor mounted equipment.
- P. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.
- Q. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed Specification 23 capabilities.
- R. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide Specification 27 wall seals.
- S. Air handling equipment and centrifugal fans shall be protected against excessive displacement that results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be Specification Type 28.
- T. Locate isolation hangers as near to the overhead support structure as possible.
- U. When conduit is required to be braced, it may be braced the same as the equivalent weight pipe.
- V. All runs will have a minimum of two transverse braces and one longitudinal brace.
 - 1. A run is defined as a length of duct or pipe without any change in direction except as allowed by offsets

3.2 VIBRATION ISOLATION OF PIPING

- A. Horizontal Pipe Isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in Specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps' Specification 14. Hangers as described in Specification 10 shall isolate horizontal runs in all other locations throughout the building. Floor-supported piping shall rest on isolators as described in Specification 6. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces, the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3". Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment, install expansion joints.
- B. Riser Isolation: Risers shall be suspended from Specification 10 hangers or supported by Specification 5 mountings, anchored with Specification 25 anchors and guided with Specification 26 sliding guides. Steel springs shall be a minimum of 0.75" except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load. Submittals must

include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

3.3 SEISMIC RESTRAINT OF PIPING

- A. Seismically restrain all piping listed as 1, 2 or 3 below. If isolated, use Specification 12 cables. Specifications 12 or 13 restraints may be used on un-isolated piping.
 - 1. Gas piping.
 - 2. Refrigeration in equipment rooms that is 1¼" I.D. and larger.
 - 3. All other piping, 2½" diameter and larger.
- B. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads or is otherwise noted in this Specification.
- C. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads or is otherwise noted in this Specification.
- D. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
- E. For all gas piping up to 5", transverse restraints must be at 20' maximum and longitudinal restraints at 40' maximum spacing.
- F. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or TEE, or combined stresses are within allowable limits at longer distances.
- G. Hold-down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
- H. Branch lines may not be used to restrain main lines.
- I. Provide joints capable of accommodating seismic displacements where pipes pass through building seismic or expansion joints or where rigidly supported pipes connect to equipment with vibration isolators. The joints must be allowed motion in all directions.
- J. A rigid piping system will not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
- L. Vertical risers not specifically engineered will be laterally supported with a riser clamp at each floor. For buildings greater than six stories high, all risers will be engineered individually.

3.4 VIBRATION ISOLATION OF DUCTWORK

- A. All discharge runs for a distance of 50' from the connected equipment shall be isolated from the building structure by means of Specification 10 hangers or Specification 5 floor isolators. Spring deflection shall be a minimum of 0.75".
- B. All duct runs having air velocity of 1,000 fpm or more, shall be isolated from the building structure by Specification 11 hangers or five floor supports. Spring deflection shall be a minimum of 0.75".

3.5 SEISMIC RESTRAINT OF DUCTWORK

- A. Seismically restrain all ductwork with Specification 12 or 13 restraints as listed below:
1. Restrain rectangular ducts with cross sectional area of 6 sq. ft. or larger.
 2. Restrain round ducts with diameters of 33" or larger.
 3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
- B. Transverse restraints shall occur at 30' intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
- C. Longitudinal restraints shall occur at 60' intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within four feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
- D. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
- E. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
- F. Unbraced ducts will be installed with a 6" minimum clearance to vertical ceiling hanger wires.
- G. Walls, including gypsum board non-bearing partitions, that have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame at all stud wall construction.

3.6 SEISMIC RESTRAINT OF MECHANICAL EQUIPMENT

- A. All mechanical equipment shall be vibration isolated and seismically restrained as per Section 2.02 of this Specification.

3.7 SEISMIC RESTRAINT EXCLUSIONS

- A. Piping:
1. All piping less than 2½" in diameter except those listed in Section 3.03, paragraph A.
 2. All piping in mechanical equipment rooms less than 1¼" I.D except where noted otherwise in this Specification and in Section 3.03, paragraph A.1.
 3. All clevis or trapeze supported piping suspended from hanger rods where the point of attachment is less than the 12" in length from the structure to top of pipe, except those listed in Section 3.03, paragraph A.1.
- B. Ductwork:
1. Rectangular, square or oval ducts less than six square feet in cross sectional area.
 2. Round duct less than 33" in diameter.
 3. No bracing is required if the duct is suspended by hangers 12" or less in length, as measured from the top of the duct to the bottom of the support where the hanger is attached. Hangers must be positively attached to the duct with 2" of the top of the duct with a minimum of two #10 sheet metal screws.

END OF SECTION 230548

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. General Provisions for Mechanical Work Section 230500 shall apply to all work performed under this Section of the Specifications and shall be considered as included herein.

1.2 SUMMARY

- A. Provide identification devices specified in this section.
- a. Section Includes:
 - b. Equipment labels
 - c. Warning signs and labels.
 - d. Pipe labels.
 - e. Duct labels.
 - f. Stencils.
 - g. Valve tags.
 - h. Warning tags.

1.3 RELATED SECTIONS

- A. All Sections of Division 23 apply to work in this Section.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
- 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
 - a. The following colors shall be used for piping identification unless noted otherwise:

Service	Legend	Background Color
Refrigerant Liquid Pipe	Liquid	Yellow
Refrigerant Suction Pipe	Suction	Yellow
Refrigerant Hot Gas Pipe	Hot Gas	Yellow
A/C Condensate	AC Cond	Yellow

Note: Color banding shall meet latest edition of NSI and OSHA requirements.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8 ½ "x 11" bond paper. Tabulate valve number, piping system, system abbreviation (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Section 15010.
- E. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Section 15010.

1.6 WARRANTIES

- A. Provide one year maintenance warranty for all pieces of equipment. See Division 1 for additional warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, products are limited to Seton, Brady or Brimar whom have a minimum of 5 years experience in the manufacturing of mechanical identification products.

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 15 sections. Where more than single type is specified for application, selections is Installer's option, but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS

- A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 duct work.
- B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
- C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

2.4 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1. Must be secured to pipe with adhesive flow arrow tape at both ends.
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker secured to pipe with flow arrow tape.
 - 2. Adhesive lap joint in pipe marker overlap.
 - 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1 1/2".
- F. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
 - 1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.5 VALVE TAGS

- A. Brass Valve Tags: Provide 1/16" (1.5mm) thick polished brass valve tags with stamp-engraved piping system abbreviation in 3/8" (8mm) high letters and sequenced valve numbers 3/4" (9.5mm) high, and with 1/8" (3mm) hole for fastener.
 - 1. Provide 1 1/2" (37mm) diameter tags, except as otherwise indicated.
 - 2. Provide size and shape as specified or scheduled for each piping system.
 - 3. Fill tag engraving with black enamel.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.6 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.7 EQUIPMENT LABELS

- A. All equipment labels shall be made of 3 ply 3/16" engraved phenolic with low glare finish. Labels shall be electrically non-conductive and abrasion resistant. Labels shall have mounting holes and adhesive backing.

2.8 WARNING SIGNS AND LABELS

- A. All WARNING labels shall be made of 3 ply 3/16" engraved phenolic with low glare finish. Labels shall be electrically non-conductive and abrasion resistant. Labels shall have mounting holes and shall be permanently attached. Background color shall be yellow with red lettering.

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which required insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Where air systems have been balanced, the Contractor shall permanently mark, ON THE DEVICE, the correct balancing settling of each valve, damper, or similar device.

3.2 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, exhaust, and outdoor air intake ductwork with stenciled signs and arrow, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 foot spacing along exposed runs.
- C. Access Doors: Provide plastic duct access door markers on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information. Where acoustic ceilings are below the access, provide duplicate marker on ceiling tile, ceiling grid, or ceiling access panel.

3.3 PIPING SYSTEM IDENTIFICATION

- A. General: install pipe markers on each system listed on the color chart Paragraph 1.04.B.1.a. indicate nominal pipe size (i.e. 4" HS) and include arrows to show normal direction of flow.
- B. Locate pipe markers and color bands as follows wherever piping and ductwork is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations and concealed above ceiling spaces.
 1. Near each valve and control device.
 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 4. At access doors and similar access points which permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.

6. Spaced intermediately at maximum spacing of 50 feet along each piping run, except reduce spacing to 25 feet in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings.

3.4 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve and control device in each piping system; exclude valves within factory-fabricated equipment, and HVAC terminal devices 50 mm and smaller and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
 1. Tagging Schedule: Valve tags shall be sequential.
- B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by the Owner.

3.5 EQUIPMENT LABELS

- A. Equipment labels shall include, but not limited to the following applicable information:

Schedule Tag	CFM
Equipment Served	Static Pressure
Equipment Manufacturer	Type of Service
Equipment Model	Filter Size & Quantity
Horsepower	Zone Served
Fan RPM	Voltage

- B. Provide equipment labels for:

Exhaust Fans	Heat Pumps
Room Fan Coil Units (ACs)	Condensing Units
Variable Frequency Drives	Rooftop Units/ERVs
Cabinet and Unit Heaters	Indoor ERVs
VAV Boxes	Temperature Control Panels

3.6 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.7 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 12) for each piping system, additional system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 1. Where stenciled markers are provided (ductwork only), clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION 230553

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Work in this section shall be performed by a certified TAB contractor retained by the Mechanical Contractor as part of this Project.
- B. The Mechanical contractor and ATC sub-contractor's services are required to assist in and support the TAB work. The cooperation and participation of the Mechanical Contractor and all subcontractors is required.
 - 1. The Mechanical contractor shall include any costs for required TAB activities, including those of their subcontractors, in the contract price.
 - 2. Include TAB participation requirements and activities in all subcontracts and schedules.
 - 3. Include the services of the sheet metal contractor for temporary capping of the duct mains for pressure testing, and reconnection of the branch ducts after testing is complete.
- C. Section Includes:
 - 1. Commissioning Responsibilities of the TAB contractor.
 - 2. Pressure testing of air duct systems.
 - 3. Balancing Air Systems:
 - a. Constant-volume air systems.
 - 4. Documenting temperatures and heat transfer of Heat Pump VRF equipment.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. 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.
- B. Certified TAB reports.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB 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. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 COMMISSIONING TEAM RESPONSIBILITIES

- A. Refer to Division 01 Section 019100 "General Commissioning Requirements" for commissioning team member roles and responsibilities.
- B. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved prior to final CxA Testing of equipment and systems.
- C. Prior to scheduling of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- D. The Mechanical Contractor shall notify the GC and CxA at least ten (10) days in advance of systems being ready for testing and balancing work, for dates to be scheduled with the CxA and TAB contractor and shall provide access for the CxA to witness testing and balancing Work.
- E. Provide technicians, instrumentation, and tools to support testing and balancing of HVAC&R systems at the direction of the CxA.
 1. The CxA will notify testing and balancing subcontractor ten (10) days in advance of the date of field verification in order for dates and times to be coordinated with the CxA, Mechanical contractor, and the ATC sub-contractor. Notice will not include data points to be verified.
 2. If re-testing is required, the testing and balancing subcontractor shall use the same instruments by model and serial number that were used when original data were collected.
 3. Failure of an item is defined by a deviation of more than 10 percent of any pertinent variable other than sound. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
 4. The Mechanical Contractor shall remedy the deficiency and notify the GC and CxA so verification of failed portions can be performed, and so that repeat of the TAB testing can be scheduled.

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 systems for installed balancing devices, such as test ports, thermometers flow-control devices, fittings, motorized and manual volume dampers. Verify that locations of these balancing devices are accessible and controllable by the manufacturer's controls and/or the BMS to set damper positions and verify that CFM readings tested match the CFM of the airflow station devices.
- 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. This contractor shall pressure test ductwork in the presence of the CxA, and as specified in Division 23 Section Metal Ducts. A leakage report shall be submitted to the GC and CxA to be forwarded to the A/E. Repeat testing of failed sections after confirmed repair by the Mechanical Contractor.
 - 1. The MC is responsible for and shall coordinate the requirements of the ductwork pressure test with his sheetmetal subcontractor.
 - 2. Advanced planning is required, including but not limited to installation of temporary caps on duct branches and mains in order to facilitate testing. Failure to plan for the tests does not alleviate the duct pressure test requirement.
 - 3. Failure to schedule the test to include attendance by the CxA will require the test to be repeated.
 - 4. Duct sections that do not pass the pressure test shall be resealed and retested. Additional TAB labor and any delay caused to the work of other trades is the responsibility of the Mechanical Contractor.
 - 5. After successful testing is completed, the duct branches shall be reconnected, sealed, and insulation repaired.
- F. Examine equipment performance data including fan 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 factory start-up, field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed. Identify and log all deficiencies (example: missing volume dampers, disconnected ductwork, missing insulation, obvious air leaks) and submit to the MC and CxA. The MC shall repair all noted deficiencies and sign off log.

- H. Examine test reports specified in individual system and equipment Sections.
- I. Replace all air filters with new.
- J. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation. Construction filters must be replaced with final filters prior to TAB. If additional construction work is on-going after the testing, additional protection should be in place to protect the system such as return register/intake filter material covers.
- K. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine operating safety interlocks and controls on HVAC equipment.
- N. 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 strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Refrigerant systems are clean, charged, and pressure tested. Confirm that branch circuit controls and LEV kits are operating properly.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- 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. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

- C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with marker, paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in U.S. standard 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. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Replace all air filters and identify clean and dirty pressure drops.
- D. Locate all volume dampers in system and correct schematic diagrams of systems' "as-built" duct layouts.
- E. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- F. 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.
- G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- H. Verify that motor starters are equipped with properly sized thermal protection.
- I. Check dampers for proper position to achieve desired airflow path.
- J. Check for airflow blockages.
- K. Check condensate drains for proper connections and functioning.
- L. Check for proper sealing of air-handling-unit components.
- M. Verify that air duct system is sealed as specified in Division 23 Section "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. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.

- c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop ERV unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. 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.
 6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, VFDs, and belt sizes to achieve indicated air-handling-unit performance.
 7. 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 will occur. 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 within specified tolerances.
 1. Measure airflow of ductwork branch ducts.
 - a. Where sufficient space in branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure CFM at a point downstream from the balancing damper and adjust volume dampers until the proper CFM is achieved.
 3. Remeasure each main and submain after all branch ducts have been adjusted. Continue to adjust submain and branch ducts to indicated CFM airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- E. Remeasure each main and submain after all inlet and outlets have been adjusted. Continue to adjust submain and branch ducts to indicated CFM airflows within specified tolerances.

3.6 PROCEDURES FOR CONDENSING UNITS AND HEAT PUMPS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.
- D. Record electrical data.

3.7 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Mode of operation (Heating/Cooling/Dehumidification).
 - 2. Dry-bulb temperature of entering and leaving air.
 - 3. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 4. Airflow.
 - 5. Air pressure drop.
 - 6. Refrigerant suction pressure and temperature.
- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.

3.8 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: +/- 10%.
 - 2. Air Outlets and Inlets: +/- 10%.
 - 3. Heating-Mode Supply Air Temperature: +/- 10%.
 - 4. Cooling-Mode Supply Air Temperature: +/- 10%.

3.9 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 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.

3.10 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.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. 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 contractor.
 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. Weather conditions and operating mode of system at time of testing.
 10. Signature of TAB supervisor who certifies the report.
 11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 12. 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.
 13. Nomenclature sheets for each item of equipment.
 14. Data for terminal units, including manufacturer's name, type, size, and fittings.
 15. Notes to explain why certain final data in the body of reports vary from indicated values.
 16. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, bypass-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.

- e. Inlet vane settings for variable-air-volume systems.
 - f. Settings for supply-air, static-pressure controller.
 - g. 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. Outdoor, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Terminal units.
 - 4. Balancing stations.
 - 5. Position of balancing devices.
- 3.11 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.
- 3.12 SPECIAL REQUIREMENTS
- A. If readings shown on the balancing report or from actual site visit are not acceptable to the Engineer, the Balancing Contractor shall spot test (witnessed by the Engineer) as many pieces of equipment or air outlets at no additional cost.
- 3.13 TRAINING OF OWNER PERSONNEL
- A. The TAB contractor shall have the following training responsibilities:
 - 1. TAB shall meet with facility staff after completion of TAB and instruct them on the following:
 - a. Review the final TAB report, explaining the layout and meanings of each data type.
 - b. Discuss any outstanding deficiencies in control, ductwork, piping or system design that may affect the proper delivery of air or refrigerant.
 - c. Identify and discuss any terminal units, duct runs, diffusers, coils, and fans that are close to or are not meeting their design capacity.
 - d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 - e. Other salient information that may be useful for facility operations, relative to TAB.

END OF SECTION 230593

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Polyolefin.
 - e. Polystyrene.
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied jackets.
10. Tapes.
11. Securements.
12. Corner angles.

B. Related Sections:

1. Division 22 Section "Plumbing Insulation."
2. Division 23 Section "Metal Ducts" for duct liners.

C. Scope:

1. Insulate refrigerant piping.
2. Insulate all copper AC condensate piping.
3. Insulate all supply and intake ductwork where connected to an outside air ducts.

1.2 SUBMITTALS

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

B. Shop Drawings:

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, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties, equipment connections, and access panels.
4. Detail application of field-applied jackets.
5. Detail application at duct access panels and volume dampers.
6. Detail application at linkages of control devices.

7. Detail field application for each equipment type.
- C. Field quality-control reports.
- 1.3 QUALITY ASSURANCE
- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting 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 and inspecting 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.

PART 2 - PRODUCTS

2.1 REFRIGERANT/COOLING CONDENSATE INSULATION

- A. Provide and install insulation on all piping and equipment as listed manufactured by Armacell.
1. Copper AC Condensate Piping: 1" thick insulation
 2. PVC or Vinyl AC Condensate Piping: No Insulation Required
 3. Refrigerant Piping, Indoors, for Split Systems: 1" thick insulation with paintable jacket
 4. Refrigeration Piping, Outdoors, for Split Systems: 2" thick insulation with Pittwrap Jacket
- B. Insulation material shall be a flexible, closed-cell elastomeric insulation in tubular form model AP Armaflex SS and AP Armaflex Sheet. Product shall meet the requirements as defined in ASTM C 534, "Specification for preformed elastomeric cellular thermal insulation in sheet and tubular form."
- C. Insulation material shall have a closed-cell structure to prevent moisture from wicking, which makes it an efficient insulation.
- D. Insulation material shall be manufactured without the use of CFC's HFC's or HCFC's. It shall also be formaldehyde free, low VOC's, fiber free, dust free and resists mold and mildew.
- E. Materials shall have a flame spread index of less than 25 and a smoke-developed index of less than 50 when tested in accordance with ASTM E 84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.
- F. Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft²-°F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
- G. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A, latest revision. The material shall be manufactured under an independent third party supervision testing program covering the properties of fire performance, thermal conductivity and water vapor transmission.

2.2 DUCT INSULATION (INDOORS)

- A. All leakage testing of ductwork to be insulated shall be completed, and resealing of areas found to not be tight, prior to the application of any insulation materials.
- B. Supply, and outside air intake ductwork shall be insulated with a minimum of 2" thick R-8 (as rated on manufacturer's packaging) fiberglass duct wrap insulation when located within interior unconditioned spaces such as duct shafts and above ceilings.
- C. Duct insulation shall be continuous through wall openings and sleeves.
- D. Insulation shall be as manufactured by Owens Corning or approved equal. Insulation shall have a foil-faced vapor barrier.
 - 1. Spiral and Oval ductwork installed exposed within indoor spaces shall be internally sound lined with 1".
 - a) Duct sizes indicated are inside clear dimension, increase overall duct size by 2" to accommodate for duct lining.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Refer to the manufacturer's written installation instruction & product data sheets for additional information, and for product specific installation requirements and instructions.
- B. All testing of ductwork and piping to be insulated shall be completed prior to the application of any insulation materials.
- C. All surfaces to be insulated shall be cleaned of all scale, rust, oil, and foreign matter and shall be dry and free of frost prior to and during application of insulation.
- D. All insulation and accessory materials shall be stored in an area that is dry and protected from the weather before and during insulation application.
- E. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- F. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- G. 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.

- H. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- I. Install multiple layers of insulation with longitudinal and end seams staggered.
- J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- K. Keep insulation materials dry during application and finishing.
- L. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- M. Install insulation with least number of joints practical.
- N. 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.
- O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- P. 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 on center.
 - 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 on center.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- Q. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement after start-up.
- S. 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.
- T. 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.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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 shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
 2. Inspect field-insulated equipment, 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 one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 3. 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.

3.4 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 1. Indoor, concealed supply, return, exhaust, and outdoor air.
 2. Indoor, exposed supply, return, exhaust, and outdoor air located in non-conditioned space.
 3. Indoor, concealed supply, return, exhaust, and outdoor air located in non-conditioned space.
 4. Indoor, exposed supply and outdoor air located in conditioned space.
- B. Items Not Insulated:
 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.

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 Refrigerant Piping
 - 1. Install insulation over pipe, fittings, valves, and specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using 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. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a paintable jacket.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION FOR GREASE DUCTS

- A. Install insulation in strict accordance with the manufacturer's instructions to maintain FM and UL listings.
- 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 fire stopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Fire stopping."

3.7 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.
 - 3. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 4. Extend jacket of outdoor insulation beyond roof flashing at least 2 inches below top of roof flashing.
 - 5. 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. 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 Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. 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 (50 mm).
 2. Pipe: Install insulation continuously through floor penetrations.
 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.8 CELLULAR-GLASS INSULATION INSTALLATION

- 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 factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches on center.
 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but 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 Fittings and Elbows:
1. Install preformed sections of same material as 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 sections of cellular-glass insulation. Secure insulation materials with wire or bands.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- 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 Fittings and Elbows:
1. Install mitered sections of pipe insulation.

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.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed 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.

3.10 MINERAL-FIBER INSULATION INSTALLATION

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 on center.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but 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 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.

C. Blanket Insulation Installation on Ducts and Plenums:

1. Secure with adhesive and insulation pins.
2. At volume damper and duct access door locations, cut insulation back to expose damper adjusters and access doors. Tape seal insulation to duct. Provide an insulation "Door" to cover the access point and mark the "Door" with highly visible fluorescent marker or tape.
3. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
4. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
5. 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 on center.

- b. On duct sides with dimensions larger than 18 inches, place pins 16 inches on center. 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 over-compress 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.
6. 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 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch on center. 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 shall 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 2 times the insulation thickness but not less than 3 inches.
7. 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 on center.
8. 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.
9. 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 on center.
- D. 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 100 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 on center.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches on center. 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 over-compress 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 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch on center. 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 shall 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 2 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 on center.

3.11 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
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.

3.12 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

3.13 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

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.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.14 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 on center. and at end joints.

3.15 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.

END OF SECTION 230700

SECTION 23 08 00 - HVAC SYSTEM COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

- 1.1 The work provided under this Division as described in this Specification is included in the scope of the Commissioning activities required to meet the Owner's goals.
- 1.2 RELATED DOCUMENTS
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this commissioning requirement.
 - B. ASHRAE Guideline 1-2007, HVAC&R Technical Requirements for the Commissioning Process.
 - C. Project OPR and BOD, for reference information only.
 - D. In addition to the drawings and general provisions of the contract, commissioning requirements are defined in the following sections:
 - 1. Section 019113 – General Commissioning Requirements
 - 2. Section 070800 – Commissioning of Thermal Moisture Protection
 - 3. Section 080800 – Commissioning of Openings
 - 4. Section 220800 – Plumbing Systems Commissioning Requirements
 - 5. Section 260800 – Electrical System Commissioning Requirements
 - 6. Section 230593 – Testing, Adjusting and Balancing for HVAC
 - 7. Section 230900 – Instrumentation and Control for HVAC
 - 8. Section 230993 – Sequence of Operation for HVAC Controls
- 1.3 SUMMARY
- A. INFORMATION COVERED IN THIS SECTION IS THE RESPONSIBILITY OF THE MECHANICAL CONTRACTOR AND THEIR ATC AND TAB SUBCONTRACTORS.
 - B. This section defines commissioning requirements for the following HVAC&R (Heating, Ventilation, Air-Conditioning and Refrigeration) systems, assemblies, and equipment:
 - 1. Energy supply systems.
 - 2. Heat generation systems.
 - 3. Cooling generation systems.
 - 4. Central-station air-handling systems.
 - 5. Air and refrigeration distribution systems.
 - 6. Heating and cooling terminal and unitary equipment.
 - 7. Energy Recovery Equipment.
 - 8. HVAC controls.
 - 9. TAB verification.
 - C. General commissioning requirements and CxA responsibilities are described in Division 01 Section 019113 and are therefore not repeated in this Section.
- 1.4 DEFINITIONS
- A. Commissioning Plan: A document, prepared by the CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
 - B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
 - C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
 - D. Commissioning Team: The individuals who through coordinated actions are responsible for implementing the commissioning process.

- E. Data logging: The monitoring and recording of flows, currents, status, pressures, etc., of equipment using stand-alone data recorders separate from the control system or the trending capabilities of control systems.
- F. Deferred Performance Tests (DPTs): Performance tests that are performed, at the discretion of the CxA, after substantial completion, due to partial occupancy, equipment operability, seasonal requirements, design, or other site conditions that disallow the test from being performed.
- G. Deficiency, Non-Compliance, Non-Conformance: A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the contract documents.
- H. DDC: Direct digital controls.
- I. Factory Testing: Testing of equipment on-site or at the factory, by factory personnel, with or without an owner's representative present.
- J. Functional Performance Test (FPT): Functional tests that are executed by the TC, and witnessed by the CxA, following the protocol written by the CxA that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. Performance testing includes the dynamic functions and operations of equipment and systems using manual or monitoring methods under various levels of operation. Systems are tested under various modes, such as during low cooling loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to respond as the sequences state.
- K. HVAC: Heating, Ventilating, and Air Conditioning.
- L. 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.
- M. Official: State or Local official having jurisdiction over the HVAC&R systems
- N. Pre-Functional Checklists (PFC): Pre-functional checklists are prepared by the CxA and completed by the Trade Contractors (TC) to verify the proper installation of new or relocated HVAC equipment in accordance with industry practices.
- O. Pre-Functional Testing (PFT): Testing performed by the Trade Contractors (TC) to verify system readiness. Pre-Functional Testing is to be completed as part of startup of the equipment in preparation for Functional Performance Testing.
- P. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
- Q. Quality Based Sampling: A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.
- R. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
- S. Seasonal Performance Tests: Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.
- T. Startup: The initial starting or activating of dynamic equipment, including completing construction checklists.
- U. Systems Manual: A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the owner during the occupancy and operations phase.

- V. "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.
- W. TAB: Testing, Adjusting, and Balancing.
- X. Training Plan or Instruction Program: A written document that details the expectations, schedule, and deliverables related to the training of project operating and maintenance personnel, users, and occupants.
- Y. Trending: The monitoring, by a building management system or other electronic data gathering equipment, recording, and analyzing of the data gathered over a period of time.

1.5 CONTRACTOR REQUIREMENTS

- A. Meet all the requirements of Section 01 91 13 "General Commissioning Requirements." In addition to component and systems level commissioning of the work listed, participation in inter-system testing and integrated commissioning of interrelated work is required. For list of all commissioned work see Section 01 91 13 "General Commissioning Requirements."
- B. Provide factory start-up and required technical personnel for participation in Owner's Commissioning.
- C. Construction and Acceptance Phase:
 - 1. Provide submittal data, commissioning documentation, O&M data and training related to Commissioning, including information from equipment suppliers.
 - 2. Attend meetings necessary to facilitate the Commissioning process (refer to Section 01 91 13 and PART 3 - EXECUTION of this specification for more information on meetings).
 - 3. Review the commissioning Issues Log for items related to contracted work and assist the commissioning team in addressing and resolving these issues.
 - 4. Complete commissioning checklists provided by Stephen Turner Inc. and return completed checklists to the Commissioning Team. Startup checklists may require specific input from the Equipment Supplier such as a copy of the Manufacturer's Startup Checklist and Factory Start-up Reports.
 - 5. Address any available Owner and Design Professional punch list items before final commissioning testing. Discrepancies and problems (differences between required and observed performance) shall be remedied before commissioning testing of the respective systems.
 - 6. Complete air system TAB with all discrepancies and problems remedied before commissioning testing of the respective air or water-related systems.
 - 7. Execute commissioning tests, which will be developed and led by the CxA. Testing will start at the components level, will proceed to the system level, and will end with inter-system testing.
 - 8. Correct issues (differences between required and observed performance) as interpreted by CxA, the Owner/OPM, and the A/E team and retest the equipment.
 - 9. Provide training of the Owner's operating staff, as required in PART 3 of this specification and elsewhere in the Contract Documents.
 - 10. Assist, communicate, and cooperate with the CxA. Provide skilled technicians familiar with this building and installed equipment to assist with commissioning testing.
- D. Warranty Period
 - 1. Execute seasonal or deferred commissioning testing, as applicable, witnessed by the CxA. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.6 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of the HVAC&R systems shall include all equipment and components associated with the Heating, Ventilation, Air-Conditioning and Refrigeration systems. These shall include, but are not limited to:
1. Indoor Fan Coil Units (IDUs) (30% sample test set of each type as selected by the A/E)
 2. Split System Air Conditioning (100% test set)
 3. Building Automation System/Automatic Temperature Controls, including operator stations, displays, alarms, metering, monitoring, sensors and control systems programming and trending (100% test set)

1.7 SUBMITTALS

- A. Refer to Division 01 Section 011000 "Submittal Procedures" for specific requirements.
- B. In addition, provide the following:
1. Certificates of readiness.
 2. Certificates of completion of installation, prestart, and startup activities (PFC).
 3. All contractor and equipment vendor/manufacturer startup and test reports and service tickets for equipment and systems.
 4. Completed Pre-Functional Testing Reports.
 5. Duct and Piping Pressure Test Reports (REQUIRED - duct pressure testing is to be included by the MC/TAB contractor and witnessed by the CxA)
 6. Testing, Adjusting, and Balancing Reports
 7. O&M manuals.
- C. Control Drawings Submittals
1. The control drawings shall have a key to all abbreviations.
 2. The control drawings shall contain graphic schematic depictions of the systems and each component.
 3. The diagrams shall include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 4. Provide a full points list with at least the following included for each point:
 - a. Controlled system
 - b. Point abbreviation
 - c. Point description
 - d. Display unit

1.8 COORDINATION

- A. Coordination of the Cx process is the responsibility of all Cx Team members.
- B. The CxA coordinates the commissioning activities through the construction manager or general contractor. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- C. The CxA, through the Owner or CM, will provide sufficient notice to the contractor for scheduling commissioning activities with respect to the Owner's participation. The CM will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. The mechanical contractor shall provide sufficient notice to the CxA for scheduling attendance at all testing activities including duct and pipe pressure testing, and equipment start-up.

1.9 REMOBILIZATION AND RETESTING FEES

- A. In general, CxA Functional Testing will include one test of each system or equipment. The cost of any additional testing, if required due to differences between required and observed performance, will be submitted to the Owner for review and direction. Following Owner review, the cost for additional testing to verify that performance in accordance with the design intent may be deducted from the Contractor's final payment by the Owner.
- B. In the event that a CxA site visit scheduled in advance with the Contractor and testing is unable to be performed through no fault of the Owner, and the CxA is not notified within 48 hours prior to the scheduled visit, the cost of the travel and time may be deducted from the contractor's final payment by the Owner.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall furnish all standard testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC&R system and controls system in Division 23, including for equipment specific to and used by TAB in their commissioning responsibilities.
- B. Refer to Division 01 Section 019113 "General Commissioning Requirements" for a detailed description of test equipment requirements.

PART 3 - EXECUTION

3.1 TRADE CONTRACTOR'S COMMISSIONING TEAM RESPONSIBILITIES

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for commissioning team member roles and responsibilities.
- B. Each trade including all Sub-contractors, Tier Contractors, manufacturers' start-up personnel, as well as direct Equipment Suppliers shall designate personnel to be responsible for coordinating commissioning activities with the Commissioning Authority as required in Section 01 91 13 "General Commissioning Requirements."
- C. The responsibilities of this contractor include, but are not limited to:
 - 1. Include any costs for Commissioning Process activities for administration and execution in the contract price.
 - 2. Include Commissioning Process requirements and activities in all subcontracts and equipment purchases.
 - 3. Ensure the cooperation and participation of all subcontractors and manufacturers of equipment or systems to be commissioned.
 - 4. Attend Commissioning Team meetings.
 - a. Attendance of regularly scheduled commissioning meetings is required by at least one (1) representative from the Contractor(s) for the systems being commissioned during delivery, installation, and start-up, and when checklists and tests are being performed.
 - b. As specific issues arise, a representative from each direct equipment supplier, and each supplier of other equipment not adequately represented by technical personnel from the responsible Contractor will be required to attend the meeting to assist in resolutions.
 - 5. Include Cx-related milestones in the construction schedule.
 - 6. Implement the training program as described in the Contract Documents. Coordinate related activities with the CxA.

7. Provide submittals to the Owner, Design Team, and CxA as detailed in the Common Work Results for HVAC 230500 and in this section.
 8. Respond to and resolve issues identified in the Cx Issues Log.
 9. Notify the CxA when systems and assemblies are ready for installation verification and testing. For repetitive assemblies, notify the CxA upon the completion of the prototype for a First Piece or Mock-Up review.
 10. Notify the OPM and Architect when duct systems are ready to be pressure tested by the TAB Subcontractor and assist as required for the testing.
 11. Notify the OPM and Architect when systems and equipment is ready for testing, adjusting, and balancing and assist as required.
 12. Complete Pre-Functional Checklists (PFC) and make corrections as required. See more detailed description in this section.
 13. Complete Pre-Functional Testing (PFT)) and make corrections as required. See more detailed description in this section. Complete Pre-Functional test procedures. Pre-Functional Testing is to be completed as part of startup of the equipment in preparation for Functional Performance Testing. Functional testing will not take place until all PFTs have been fully executed and completed reports have been submitted to the CxA.
 14. Functional Performance Test (FPT): Once Pre-Functional Tests are complete, functional test verification will be scheduled and demonstrated in the presence of the CxA.
 15. Maintain the Project Record Documents in accordance with the requirements of the Contract Documents.
- D. The suppliers of major equipment are required to support the Commissioning Team in the following manner:
1. Provide all information required for the proper Start-up and Operation and Maintenance of the system or assembly in the initial submittal, as detailed in the Contract Documents.
 2. Provide the requirements to maintain the warranty in the initial submittal, as detailed in the Contract Documents.
 3. Coordinate and provide results of all factory tests required in the Contract Documents.
 4. Participate in the training process as detailed in the Contract Documents.
 5. Demonstrate operation and performance of equipment and assemblies as detailed in the Contract Documents.
 6. Coordinate and participate in set-up of programming features with the MC, ATC, and TAB contractors.

3.2 GENERAL DOCUMENTATION REQUIREMENTS AS A PREREQUISITE TO TESTING

A. Submittals

1. Provide submittals to the as detailed in the Common Work Results for HVAC 230500. Additional requirements for this Section are below.
2. Testing, Adjusting, and Balancing:
 - a. The TAB Contractor shall submit a project-specific TAB Submittal six (6) weeks prior to starting TAB work. This plan will be developed after the TAB Contractor has some familiarity with the systems and associated control systems. The Submittal shall address each system and component, and shall include but not be limited to items below.
 - b. TAB Contractor's certifications and credentials to perform the contracted work.
 - c. Certification that the TAB has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.

- d. The identification and types of measurement instruments to be used and their most recent calibration date.
 - e. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data to be gathered for each.
 - f. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - g. Final test report forms to be used.
 - h. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / sub-main proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.
 - i. List of all air flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - j. The TAB plan must include project specific takeoffs of all the DP and other values required to be determined during TAB.
 - k. Details of how total flow will be determined.
 - l. Air: sum of terminal flows or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - m. Specific procedures that will ensure that air systems are operating at the lowest possible pressures and provide methods to verify this.
 - n. Confirmation that TAB contractor understands the outside air ventilation criteria under all conditions.
 - o. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
 - p. Details of methods for making any specified coil or other system plant capacity measurements. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
 - q. Phasing plan for performing TAB work by floor or area, and details regarding specified deferred or seasonal TAB work.
 - r. Details of any specified false loading of systems to complete TAB work.
 - s. Procedures for verifying required room pressure differentials.
 - t. Details of any required interstitial cavity differential pressure measurements and calculations.
 - u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - v. Plan for formal progress reports (scope, frequency and distribution list).
 - w. Plan for formal deficiency reports (scope, frequency and distribution list).
 - x. Procedures for addressing partial build-out, diversity, and part load issues including false loading or other approaches where allowed.
 - y. Methods to make all specified refrigerant coil and system capacity measurements.
 - z. Specific procedures to ensure air distribution systems operate at the lowest possible pressures and the methods to verify and document this.
 - aa. Proposed points for sound measurements including proposed measurement methods.
3. HVAC Submittals:

- a. Include ranges for all thermometers, pressure gauges, and other measuring devices.
 - b. Provide performance data including range, accuracy, data storage, local read-out, and data connections for each meter type submitted.
 - c. Include service designation for each individual system, including each duct system and piping system, fittings and joining materials, each insulation system, all valves, all piping specialties, and all accessories. These shall be presented in table format, to clearly indicate where each type of material will be used for each system. Generic cut sheets that do not indicate the specific application are not acceptable. Copies of the project specifications are not acceptable.
 - d. Provide detailed product data for each piece of equipment including capacities, electrical components and requirements, including all specified product attributes.
 - e. Provide performance curves (full and part-load as applicable) for each fan and piece of unitary equipment submitted.
 - f. Provide Manufacturers' detailed installation requirements clearly marked (arrow, underline, circled, etc.) to indicate only the intended item.
 - g. Provide Manufacturers' detailed start-up requirements and procedures clearly marked (arrow, underline, circled, etc.) to indicate only the intended item.
 - h. Provide Manufacturers' operation instructions clearly marked (arrow, underline, circled, etc.) to indicate only the intended item.
 - i. Provide Manufacturers' recommended maintenance and troubleshooting procedures clearly marked (arrow, underline, circled, etc.) to indicate only the intended item.
 - j. Provide Warranty and clear statement of Owner's obligations to maintain equipment to preserve warranty.
- B. Red-lined and As-Built Drawings
1. Provide submittals as detailed in the Common Work Results for HVAC 230500. Additional requirements for this Section are below.
 2. The contractor shall verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 3. Preliminary red-lined drawings shall be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 4. The Contractor shall incorporate changes resulting from Functional Testing into the final as-built drawings, which will be created from the red-lined drawings.
 5. This contractor, as defined in the Contract Documents, shall generate the As-Built drawings.
 6. All red-lined drawings shall be available for review on-site by the Owner and the CxA.
- C. Operation and Maintenance Data
1. Provide submittals to the as detailed in the Common Work Results for HVAC 230500. Additional requirements for this Section are below.
 2. Within 4 weeks of completing the submittal review process ("Approved" Product or Shop Drawing Submittal), provide final, or if that is not yet available, draft electronic format O&M Manual to the CxA for use in developing Functional Performance Tests.
 3. Final Controls O&M Manuals shall include:
 - a. Component installation, operation, and maintenance instructions for each building level, floor level, and equipment level controller, integrator, or field panel.
 - b. Calibration requirements and intervals by sensor and positioned or actuator type.
 - c. Specific instructions on how to perform all functions, access all features, and switch to each mode in the workstations and controllers.

- d. Software version and security update requirements.
 - e. Sequences of operations for each piece of equipment.
 - f. Final points list including cross-references to final room numbers and equipment designations provided by the Owner during Construction.
 - g. Full as-built file of all schedules and setpoints in electronic format as specified in the contract documents.
 - h. Actual room numbers as posted in the building shown on controls drawings.
4. The CxA will review the O&M literature once for conformance to project requirements.
- D. Equipment Start-up Reports
1. For all commissioned systems and equipment, one copy of the equipment manufacturer's or Contractor's start-up report shall be provided to the CxA for review and to document that the equipment is installed, operational, and ready for commissioning testing.
 2. Copies of additional testing performed including but not limited to duct pressure tests, vibration analysis required elsewhere in the specifications shall be provided to the CxA.
 3. For all third party testing required elsewhere in this specification or by code, provide test reports to the CxA for review and to document that the testing has been performed. Coordinate dates for third party testing in advance with the CxA to allow commissioning personnel to witness selected tests.
 4. The Contractor shall ensure that the actual room numbers as posted in the building are used in the controls programming and point names.
- E. Systems Manual Requirements:
1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
 2. Documents for the Systems Manual shall be supplied to the CxA by each trade in the formats determined by the CxA.
 3. Final approved versions of the following information for the Systems Manual:
 - a. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - b. As-Built System Diagrams
 - c. Verified Record Drawings
 - d. Test Results not otherwise included in Cx Record
 - e. Periodic Maintenance Information for computer maintenance management system
 - f. Recommendations for recalibration frequency of sensors and actuators
 - g. Training Records, Information on training provided, attendees list, and any on-going training
 4. This information shall be organized and arranged by building system.
 5. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.
- F. PREFUNCTIONAL CHECKLISTS
1. The Pre-Functional Checklist shall be completed as part of the TC's initial checkout of the equipment to ensure that the equipment installation is complete and is prepared for Pre-Functional Performance Testing.
 2. With assistance from the installing contractors, the CxA will prepare Checklists for all commissioned components, equipment, and systems.

3. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.
 - a. Return draft construction checklist review comments within [10] days of receipt.
4. When review comments have been resolved, the CxA will provide final construction checklists, marked "Approved for Use, (date)." Use only Approved checklists.
5. The construction checklists, developed by the CxA, are to be completed by this contractor (or its subcontractors), before and during the startup process and verified by the CxA. Provide completed copies to the CxA at regular intervals for verification.

3.3 PRE-FUNCTIONAL TESTING

- A. In order to verify that the systems and equipment are ready for final Functional Performance Testing witnessed by the CxA, the Contractor will complete the Pre-Functional Checklists and perform Pre-Functional Testing independent of the CxA. Pre-Functional Testing shall consist of performing the complete Functional Testing with test requirements provided by the CxA. Through this process, the Contractor will validate the test procedure and provide a marked-up version of the test complete with results and identification of the specific units tested.
- B. Perform pre-functional testing for all systems and sequences to confirm proper operation of programs and equipment for all operating modes, including but not limited to, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, special sequences, and alarm conditions.
- C. Inspect and verify the position of each device and interlock identified on checklists.
- D. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- E. The contractor shall install testing and measuring instruments and logging devices to record test data as directed by the CxA.
- F. Once a completed test is provided indicating successful operation of the system, the CxA will schedule the Functional Testing as described below.
- G. Functional testing will not take place until all PFTs have been fully executed and completed reports have been submitted to the CxA.

3.4 FUNCTIONAL TESTING GENERAL REQUIREMENTS

- A. The performance of the testing of all commissioned equipment and systems is the responsibility of the Contractors. The CxA will develop the functional performance tests with the assistance of the installing contractors, and upon the successful completion of Pre-Functional Testing as described above, will coordinate the testing process, and witness the tests that are performed by the Contractors. In addition, the CxA will prepare plans for, assist with execution of, and document tests of commissioned equipment overseen by regulatory authorities and ensure that such tests meet the rigor desired by the Owner. The CxA will coordinate the retesting of equipment until satisfactory performance is achieved.
- B. The functional performance testing will include operating the systems and components through each of the written sequences of operation, other significant modes and miscellaneous alarms, power failure, and security alarm when impacted by and interlocked with commissioned equipment. Sensors and actuators shall be calibrated during construction check listing by the installing contractors and spot checked by the CxA during functional testing. Tests on HVAC equipment shall be done, if possible, in their proper operating season (cooling in summer, heating in winter). Any equipment that operates in both seasons, such as the heat pumps, should ideally be tested in both seasons. However, if this is not possible, some manipulation of setpoints and control points will be done to simulate the necessary conditions. Functional testing will be done using conventional manual methods, control system trend logs, and stand-alone data loggers as required to provide a high level of confidence in proper system function, as deemed appropriate by

- the CxA and the Owner. A report will be provided that includes all of the issues identified during the testing process.
- C. Provide qualified technicians, instrumentation, tools, and equipment to test performance of air, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal and unitary equipment.
 - D. Provide qualified technicians, instrumentation, tools, and equipment to test performance of acoustic, vibration isolation, and seismic controls.
 - E. Certify to the CxA that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents based on Pre-Functional Testing having been completed by the Mechanical contractor and/or their subcontractors, for each component and system prior to scheduling Cx Functional Testing.
 - 1. Each direct equipment supplier, and each supplier of other equipment not adequately represented by technical personnel from the responsible Contractor shall assist the installing contractor in commissioning testing.
 - F. Certify to the CxA that HVAC&R instrumentation and control system installation including all components and programming have been completed and calibrated, that they are operating according to the Contract Documents based on pre-functional testing of each sequence, points are set up and are being trended in the BMS, and that pretest set points have been recorded.
 - 1. The Controls Contractor shall provide signed and dated certifications for the completion of the programming, point to point ring outs, and check out of each controlled device, equipment, and system prior to functional performance testing. Any programming to be completed during functional performance or inter-system testing shall be clearly indicated.
 - 2. The Controls Contractor shall implement control system trend logs at the direction of the CxA prior to the start of on-site functional performance testing. A comprehensive trend review will be performed prior to any on-site functional performance testing, to confirm that all systems appear to be functioning properly before physically traveling to the project site. The controls contractor must provide a minimum of 48 hours of trends of all requested control points at 1 minute time intervals starting on a Sunday and ending on a Monday.
 - 3. As a component of the test procedures, the CxA will identify specific system trends to be set up and then analyze the trend and monitoring data as a method of verifying performance.
 - G. Certify that testing, adjusting, and balancing has been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work completed and approved, and any required rebalancing has been completed.
 - H. Additional Requirements for Testing Specified Elsewhere
 - 1. HVAC Piping Pressure Testing.
 - 2. HVAC Duct Pressure Testing.
 - 3. The Construction Manager (CM) shall provide a copy of the proposed test procedure to the CxA for review.
 - 4. The CM shall notify Stephen Turner Inc. at least two days in advance of the date and time the test is scheduled.
 - 5. The CM shall provide copies of field and final test results to the CxA for review for consistency with the Owner's Project Requirements.
 - 6. Energy Supply System Testing: Provide QUALIFIED technicians, instrumentation, tools, and equipment to test performance of fuel systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
 - I. General Test Procedures:

1. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
2. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
3. Tests shall be performed using design conditions whenever possible.
4. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
5. The CxA may direct that set points be altered when simulating conditions is not practical.
6. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
7. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
8. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 FUNCTIONAL TESTING PROCEDURES

- A. Acceptance criteria and test details will be in accordance with the related sections including Division 01 Section 019113 Commissioning General Requirements.
- B. Any equipment or system that cannot be adequately tested at the time of the initial testing due to seasonal operating issues will be retested in their primary operating season. Whenever possible, systems will be tested under load to verify system capacity and function.
- C. The CxA will witness the Initial tests. Each contractor will be responsible, as required, to put the system in various modes of operation, to fix minor problems found during the test (i.e. problems that can be fixed without delaying the completion of the test), and to witness the testing. Where the CxA develops a procedure for the test, the contractor shall implement the test to the satisfaction of the CxA.
- D. The CxA will provide all commissioning team members (construction manager, contractors, Design Professional, Owner, etc.) the commissioning test procedures prior to scheduled testing. If no comments are received from a particular commissioning team member, that shall constitute acceptance of the commissioning test procedures as is.
- E. The CxA shall schedule and witness the testing once all commissioning checklists (with exception of the TAB Checklists) have been completed by the contractors and accepted by the CxA.
- F. INITIAL TESTING – Building Automation Systems
 1. The emphasis of the initial commissioning testing is on the building automation system performance, since many of the building functions have the control system as a common component.
 2. Included in this work will be sample-based verification of instrument and sensor calibration, access to components, labeling of devices, clear sequences and shop drawings.
 3. The verification of the control system will be accomplished as an on-going task during construction to identify and resolve systemic issues early in the project.

4. The building automation system operation shall be sufficiently operational prior to the TAB of the system. It is understood that a portion of the final building automation system startup occurs in conjunction with the TAB work. The intent of this requirement is for the TAB work to be productive and not be hampered by a control system that is not sufficiently functional.
 5. The commissioning testing of the control system will utilize the controls system instrumentation for testing. Therefore, the first portion of the control system testing will be verification of the sensors, inputs and outputs.
 6. Point-to-Point Verification: All wiring shall be checked out by the controls contractor from end to end, point to point, from field to computer screen to ensure correct connection and a system free from wiring deficiencies. The Controls Contractor shall document this verification and provide to Stephen Turner Inc. prior to start of Functional Performance Testing.
 7. Commissioning verification of sensors will be made using the sampling method; an exhaustive re-test of all control system inputs and outputs will not be conducted by Stephen Turner Inc. Prior to Stephen Turner Inc. verification, the control contractor shall be responsible for complete input/output checkout quality assurance.
 8. Sensor and Actuator Calibration, General:
 - a. This section is included to emphasize the importance of the control contractor calibrating the instrumentation, and to make clear the requirement for same; and that "factory calibration" or "calibration by exception" is not acceptable.
 - b. All field-installed temperature, relative humidity, CO2, and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the Owner in advance. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided to Stephen Turner Inc. need not be field calibrated.
 - c. All procedures used shall be fully documented, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
 9. Sensor Calibration Methods
 - a. All Sensors. Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end.
 - b. Sensors without Transmitters. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor is within the specified tolerances. If not, calibrate or replace sensor.
 - c. Sensors with Transmitters. Connect a signal generator. Adjust transmitter zero and span to match the signal generator until the ammeter reads 4 mA. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading is within the specified tolerances. If not, replace sensor and repeat.
 10. Damper Stroke Setup and Check
 - a. Set fans to normal operating mode. Command damper closed, visually verify that the damper is closed and adjust output zero signal as required. Command damper open, verify position is full open and adjust output signal as required. Command damper to a few intermediate positions. If actual damper position doesn't reasonably correspond, repair or replace actuator.
 - b. Closure for normally closed dampers. Disconnect power to the actuator motor and verify the damper moves to full closed position. Restore to normal.
 - c. Normally open dampers: disconnect power to the actuator motor and verify the damper moves to full open position. Restore to normal.
- G. The systems in the building will be operated in different modes of operation to verify the control system responds properly. This testing provides both the Owner and Contractor with

documentation that the control system was operating properly at Project Acceptance. The tests include but are not limited to:

1. Sequence of control for:
 - a. Central Air Distribution Systems
 - b. Local Air Distribution System
 - c. VRF systems
2. Operator's Workstation graphics display
3. Trend logs
4. Status review screens, out of bounds checks, and alarming

H. INTERMEDIATE TESTING – Testing, Adjusting, and Balancing

1. The TAB contractor, upon request by the CxA if necessary during system troubleshooting, shall provide the CxA with the technician(s) who accomplished the TAB, along with the specific equipment used for the TAB, to verify and re-test between 10% and 20% of the TAB final report. Included in this work will be:
 - a. Sample-based verification of measured quantities
 - b. Review of firm qualifications
 - c. Review of instrument calibration records
 - d. Review of basic procedures. Particular emphasis will be placed on avoiding the use of iterative methods (repeat measurements) acknowledging the fact that changes in branch flows have an overall system effect.
2. The TAB Contractor shall provide the field reports or draft TAB reports to the CxA within one week of completion for each system or area, before functional performance testing.
3. The TAB Contractor shall make skilled technicians and instruments used during TAB available to address functional performance test results that are at variance with TAB reports.

I. SYSTEM LEVEL TESTING

1. Additional commissioning testing will be conducted after testing of the control system and TAB work, but prior to occupancy of the building. This testing will provide both the Owner and Contractor with documentation that the system operated correctly according to the Owner's Project Requirements. These tests are typically performed at the room level, where a sample of rooms is selected for review.
2. The CxA will lead this portion of commissioning testing. Each Contractor will be responsible, as required, to put the system in various modes of operation, to fix minor problems found during the test (i.e. problems that can be fixed without delaying the completion of the test), and to witness the testing. Where the CxA develops a procedure for the test the Contractor shall implement the test to the satisfaction of the CxA.
3. Contractors shall attend and operate equipment during commissioning testing as required by the specific test being performed.
4. The CxA shall schedule and administer the testing once all commissioning checklists have been completed by the Contractors and accepted by the Commissioning Authority.

J. INTER-SYSTEM TESTING

1. Additional inter-system testing is required under the Owner's Commissioning process to ensure that work in this Division is properly interoperable with other work. Contractors shall participate in system level and inter-system testing. Testing will include operation under both normal power and emergency power where applicable; change-over and transition between different operating modes; and complete exercising of systems through all modes and sequences.
 - a. VRF systems

- b. Fire detection and life safety systems
- c. Metering system
- d. Plumbing systems including but not limited to Domestic Hot Water and pumps
- e. Tel/data systems
- f. Lighting controls, indoor and outdoor
- g. Power systems
- h. Emergency power systems, including recovery from utility power loss
- i. Shade systems

3.6 DEFICIENCIES

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for additional requirements pertaining to deficiencies, non-conforming conditions, cost of retesting, or failure due to manufacturing defects.
- B. If the failure rate of a similar family of equipment or devices is greater than 10%, the Owner shall be notified. The matter shall be addressed by the Owner, GC, CxA, and other applicable parties. The failure issue shall be resolved to the Owner's satisfaction.
- C. Each direct equipment supplier, and each supplier of other equipment not adequately represented by technical personnel from the responsible Contractor, shall also be required to assist the installing contractor in resolving commissioning issues.

3.7 APPROVAL

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for additional approval procedures.

3.8 DEFERRED TESTING

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for additional requirements pertaining to deferred testing.

3.9 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section 019113 "General Commissioning Requirements" for additional owner training requirements.
- B. The Mechanical Contractor shall provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of mechanical equipment.
 - 1. Provide a training plan to the CxA prior to any training.
 - 2. A training agenda for each training session shall be submitted to the CxA one (1) week prior the training session.
 - 3. Training shall occur after functional testing is complete, unless approved otherwise by the Owner.

END OF SECTION 230800

SECTION 23 09 00 - INSTRUMENTATION AND SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. This Section includes control sequences for DDC monitoring and control of HVAC systems, subsystems, and equipment.
- C. See Division 23 Section 230800 "Commissioning of HVAC" for requirements that relate to this Section.
- D. See Division 26 for electrical installation requirements. Controls Subcontractor is responsible for all control wiring – including line and low voltage wiring.
- E. Refer to Specification Section 01 23 00 for Alternate pricing requirements.

1.2 DEFINITIONS

- A. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- B. Authorized Systems Integrator: A certification attained through an authorized distributor of the Johnson Controls Facility Explorer BAS for independent BAS Controls Contractors. Authorized Systems Integrators will be defined as either a Gold, Silver, or Bronze level ASI.
- C. Binary: A two-state system where an "ON" condition is represented by one discrete signal level and an "OFF" condition is represented by a second discrete signal level. Can be used interchangeably with the word "Digital."
- D. Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this BMS Subcontractor and to be interfaced to the associated work of other related trades.
- E. BMS Subcontractor: The Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS work. The term may be used interchangeably with: Automatic Temperature Control (ATC) subcontractor; Direct Digital Control (DDC) subcontractor; Temperature Controls Contractor.
- F. Control Sequence: A BMS programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives. Collectively the control sequences are referred to as Sequence of Operation.
- G. Direct Digital Control (DDC): The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- H. BMS Network: The total digital on-line real-time interconnected configuration of BAS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements

individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.

- I. Node: A digitally programmable entity existing on the BMS network.
- J. BMS Integration: The complete functional and operational interconnection and interfacing of all BMS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.
- K. Provide: The term "Provide" and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- L. PC: IBM-compatible Personal Computer from a recognized major manufacturer
- M. Furnish: The term "Furnish" and its derivatives when used in this Division shall mean supply at the BMS Contractor's cost to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BAS, calibrate, test, commission, warrant and document.
- N. Wiring: The term "Wiring" and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.
- O. Install: The term "Install" and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- P. Protocol: The term "protocol" and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.
- Q. Software: The term "software" and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BAS configurations.
- R. The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- S. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.

1.3 SUBMITTALS

- A. Product Data: For each control device indicated.
- B. Shop Drawings:
 - 1. Schematic flow diagrams.
 - 2. Power, signal, and control wiring diagrams.
 - 3. Damper schedule.
 - 4. Valve schedule.
 - 5. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
 - 6. Control System Software and Hardware details
- C. Software and firmware operational and warranty documentation.

- D. Field quality-control test reports.
- E. Operation and maintenance data.

1.4 SCOPE

- A. Provide manufacturer's controls. All mechanical systems shall be automatically controlled. Where no description of operation is indicated for a particular system or device, the contractor shall select appropriate control scenarios and review them with the engineer prior to proceeding. All controls shall be arranged and designed for maximum energy conservation.
- B. The DDC/ATC Subcontractor shall be responsible for installation of control devices furnished by equipment manufacturers and installed in the field.
- C. Interfacing control and monitoring of manufacturer supplied controls shall be by this contractor.
- D. Provide incidental 110V power wiring to panels and control transformers where not shown on electrical drawings.
- E. The DDC/ATC Subcontractor shall provide all low and line voltage wiring required for the installation and operation of the BMS. Refer to Division 26 for wiring standards and source of power.
- F. Alarms, where applicable and all interlocking wiring required shall be provided by the ATC Subcontractor.
- G. The DDC/ATC Subcontractor shall review and study all HVAC, Electrical, Plumbing, and Fire Protection drawings and entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc., he is required to provide. Numerous references to the ATC Subcontractor are made throughout this specification identifying work to be performed under this Section in addition to work specifically indicated under this paragraph.
- H. The controls systems shall be installed by competent control mechanics and electricians regularly trained by the manufacturer of the control equipment. All control equipment shall be the product of one (1) manufacturer and all ATC components shall be capable of interfacing with the HVAC equipment. The factory trained control contractor must maintain adequate staff and offer standard services to fully support the owner in the timely maintenance, repair, and operation of the control system. Contractors who do not maintain such staff and offer services or must develop some for this project are not acceptable. Bids from franchised dealers or others whose principal business is not the installation and service of temperature control systems will not be acceptable. The ATC contractor is responsible for providing software upgrades to maintain the system with the most up to date versions available at the end of the warranty period.

1.5 QUALITY ASSURANCE

- A. The DDC/ATC Subcontractor shall be regularly engaged in the engineering, programming, installation and service of total integrated building management systems.
- B. The DDC /ATC Subcontractor shall have a fully staffed branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24-hour, 7-day-a-week basis.
- C. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the HVAC Controls business for at least the last five (5) years.

1.6 SEQUENCE OF OPERATION

- A. Split system: Outdoor condensing units & associated indoor evaporator units:
1. The indoor evaporator unit shall operate off the manufacturer's wall-mounted simple MA thermostat to maintain the space cooling and heating setpoint.
 2. When the building is occupied, the split system shall be on, and the fresh air damper shall be open. The room cooling setpoint shall be 72°F, and heating setpoint shall be 68°F (adjustable).
 3. When the building is unoccupied, the split system shall be on, but running at the unoccupied setpoints, and the fresh air damper shall be closed. The room cooling setpoint shall be 75°F, and heating setpoint shall be 65°F (adjustable).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Equipment Controllers: Provide Manufacturer's controls. For the split system provide with wired simple ma controller thermostat.

2.2 THERMOSTATS (NON-DDC)

- A. Manufacturers:
1. Erie Controls.
 2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
 3. Heat-Timer Corporation.
 4. Sauter Controls Corporation.
 5. Tekmar Control Systems, Inc.
 6. Theben AG - Lumilite Control Technology, Inc.
- B. 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.
- C. 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.
- D. 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 air ducts with flanges and shields.
 2. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 3. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 4. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.

5. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- E. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:
 1. Reset: Manual.
 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- F. Room Thermostat Cover Construction: Provide sample for Owner approval.
- G. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- H. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft of coil surface.
- I. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
 1. Bulb Length: Minimum 20 feet.
 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.3 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 2. 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.
 3. 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 .
 4. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf .
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 1. Manufacturers:
 - a. Belimo Air Controls (USA), Inc.
 2. 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.
3. Coupling: V-bolt and V-shaped, toothed cradle.
 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 6. Power Requirements (Two-Position Spring Return): 24 / 120 / 230 V ac.
 7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 9. Temperature Rating: Minus 22 to plus 122 deg F.
 10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

2.4 DAMPERS

A. Manufacturers:

1. Air Balance Inc.
2. TAMCO (T. A. Morrison & Co. Inc.).
3. Nailor
4. Greenhekck

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 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.

2.5 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. 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.
- B. Install guards on thermostats in the following locations:
 - 1. Entrances.
 - 2. Public areas.
 - 3. Where indicated on the drawings.
- C. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- E. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- F. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- G. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- H. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.3 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. Refer to the requirements of section 230800 "Commissioning of HVAC" for additional requirements.
- C. 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 controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 6. Test each system for compliance with sequence of operation.
 - 7. Test software and hardware interlocks.
- D. 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 pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 6. Check temperature instruments and material and length of sensing elements.
 - 7. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 - 8. 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.
- E. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 DEMONSTRATION

- A. Refer to Specification section 230800 "Commissioning of HVAC" for additional requirements.

- B. The BMS subcontractor shall be present onsite for Testing and Balancing activities and shall calibrate the control system based on these measurements.
- C. The BMS subcontractor shall complete point-to-point check and testing of all BMS work prior to commissioning. The BMS subcontractor shall then be present onsite for commissioning activities and shall demonstrate the functionality of the BMS to the commissioning agent. Deficiencies in the HVAC controls systems shall be rectified without delay.
- D. The Sequence of Operation and the Graphic User Interface shall be programmed by the BMS subcontractor based on the approved submittals. During commissioning, aspects of the approved sequence of operation or graphics may need optimization. Include 40 hours of labor to implement programming changes as directed by the Mechanical Engineer.
- E. The BMS subcontractor shall provide on-site training for owner's maintenance personnel to adjust, operate, and maintain the BMS. In addition, provide offsite factory training by the Johnson Controls Training Institute for (2) owner's maintenance personnel, 5-day course, "FX MSTP Field Controller Engineering" course or equal.

END OF SECTION 230900

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2. Suction Lines for Heat-Pump Applications: 325 psig.
 - 3. Hot-Gas and Liquid Lines: 325 psig.

1.3 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual 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.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L.
- B. Wrought-Copper Fittings: ASME B16.22.

- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. 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. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze.
 - 2. Packing: Molded stem, back seating, and replaceable under pressure.
 - 3. Operator: Rising stem.
 - 4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
 - 5. Seal Cap: Forged-brass or valox hex cap.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Working Pressure Rating: 500 psig.
 - 8. Maximum Operating Temperature: 275 deg F.
- C. Check Valves:
 - 1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 - 2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 - 3. Piston: Removable polytetrafluoroethylene seat.
 - 4. Closing Spring: Stainless steel.
 - 5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Maximum Opening Pressure: 0.50 psig.
 - 8. Working Pressure Rating: 500 psig.
 - 9. Maximum Operating Temperature: 275 deg F.
- D. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Copper spring.
 - 5. Working Pressure Rating: 500 psig.

- E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
 8. Manual operator.
- F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig.
- H. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- I. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- J. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240 deg F.

- K. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina or charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240 deg F.
- L. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina or charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240 deg F.
- M. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- C. ASHRAE 34, R-410A: Puron.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type K, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

- C. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- E. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications:
 - 1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 2. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 3. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.
- G. Safety-Relief-Valve Discharge Piping:
 - 1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 2. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 - 3. NPS 4: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at strainers if they are not an integral part of strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve and in the suction line at the compressor.
- L. Install flexible connectors at compressors.

3.3 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 Shop Drawings.
- B. Install refrigerant piping according to 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 Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" 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 Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.

- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. 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.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
- V. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
 2. Test refrigerant piping and specialties. 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 Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage 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.

3.7 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.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.

4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
3. Division 23 Section "Vibration and Seismic Control for HVAC Piping and Equipment" for vibration and seismic control requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall 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."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2013.

1.3 SUBMITTALS

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

B. 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 of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.

E. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports or AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2013, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 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.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) 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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," 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. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "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."
- E. Square throat round heel elbows are not allowed. Any square throat round heel elbows found installed by this contractor will be ordered to remove and replace with square throat square heel elbows with vanes at no additional cost to the project.

2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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."

1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," 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 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 shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: 16 GAUGE Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, 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.

2.4 SEALANT AND GASKETS

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. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. 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.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated 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 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated 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.

2.6 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Ductmate Industries, Inc.
 - 3. Hilti Corp.
 - 4. Kinetics Noise Control.
 - 5. Loos & Co.; Cableware Division.
 - 6. Mason Industries.
 - 7. TOLCO; a brand of NIBCO INC.
 - 8. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction].
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. 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.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.["Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."]

3.2 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 1. Space lateral supports a maximum of 40 feet O.C., and longitudinal supports a maximum of 80 feet O.C.
 2. Brace a change of direction longer than 12 feet (3.7 m).
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT CLEANING

- A. Clean all new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 6. Provide drainage and cleanup for wash-down procedures.
 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

- A. Supply Ducts:
1. Ducts Connected to Fan Coil Units, and Heat Pumps:
 - a. Pressure Class: Positive 2-inch wg.
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 4-inch wg.
- B. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, and Heat Pumps:
 - a. Pressure Class: Positive or negative 2-inch wg.
 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg
- C. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
 2. PVC-Coated Ducts:
 - a. Exposed to Airstream: Match duct material.
 3. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 4. Aluminum Ducts: Aluminum.
- D. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 with vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

- c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or welded.
- E. Branch Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: 45-degree entry.
 - 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 45-degree lateral.
 - b. Velocity 1000 to 1500 fpm: 45-degree lateral.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers and Remote Operated Volume Dampers
3. Control dampers.
4. Fire Dampers.
5. Flange connectors.
6. Turning vanes.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Flexible ducts.
10. Duct accessory hardware.
11. Louvers

1.2 SUBMITTALS

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

B. 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 and Remote Operated volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - e. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems", and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. 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.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and top grade finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. 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.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.
 - 4. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 4-inch wg.
- E. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.
- F. Blades: Multiple opposed blades, with sealed edges.
- G. Blade Action: Opposed Blade.
- H. Blade Seals: Low leak, Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Galvanized steel.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Bird.
9. 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. C & S Air Products.
 - b. Air Balance Inc.; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
2. **Low leakage rating**, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - 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-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & S Air Products.

- b. Air Balance Inc.; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
 2. **Low leakage rating**, with linkage outside airstream.
 3. Suitable for horizontal or vertical applications.
 4. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with 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. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Axles: Galvanized steel.
 7. Tie Bars and Brackets: Aluminum.
- C. Jackshaft:
1. Size: 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.
- D. Manual 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.
- E. Remote Operated Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & S Air Products.
 - b. Air Balance Inc.; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
 2. **Low leakage rating**, with linkage concealed in frame.
 3. Suitable for horizontal or vertical applications.
 4. Frames: Steel hat-shaped 13 gauge channels; frames with 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. 6" 16-gauge triple v, opposed blade, or single blade.
6. Blade Axles: ½" plated steel hex.
 7. Bearings: Synthetic
 8. Sleeve: Optional 20 gauge 10" long
- F. Remote Operated Damper Hardware:
1. Control Shaft: 1/2" x 3" round drive axle with a control arm/screw-drive assembly factory installed on a stand-off bracket attached to an 10" x 20 ga. side plate secured to the damper frame.
 2. Remote Control Cable Assembly: 5/32" Ø x length to suit application cable with 3/16" allen hex-head drive, 2" wide steel mounting bracket, 15/16" x 1-1/2" long round plastic tube and optional nickel plated steel finishing plug.
 3. Include tee-handle hex tool for operator.
 4. Label finishing plug to identify service.

2.4 CONTROL DAMPERS

- A. Control dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Basis of design for outside air dampers is Greenheck model VCD-34. Basis of design for return air dampers is Greenheck model VCD-33.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. C&S Air Products
 2. Greenheck Fan Corporation.
 3. Nailor Industries Inc.
 4. Ruskin Company.
- C. Dampers shall consist of a 16 ga galvanized steel channel frame with 5 in depth; airfoil shaped, galvanized steel double skin construction blades 14 ga equivalent thickness filled with 0.5 in fiberglass insulation; blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper; 0.5 in dia. Plated steel axles turning in synthetic sleeve bearings; extruded silicone rubber blade seals for 300 f maximum temperature; 304 ss jamb seals; and external (out of the airstream) blade-to-blade linkage.
- D. Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval showing damper suitable for pressures to 8 in wg, velocities to 4,000 ft/min and temperatures to 180 f. Testing and ratings to be in accordance with AMCA standard 500.
- E. Damper manufacturer's printed performance data showing standard air leakage less than 6 CFM @ 4 in w.g. shall be submitted for approval. Testing and ratings shall be per AMCA standard 500.

2.5 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ruskin Company.
 2. Potteroff
 3. C&S Air Products
 4. Air Balance Inc.; a division of Mestek, Inc.
 5. Greenheck Fan Corporation.

6. Nailor Industries Inc.
- B. Type: Dynamic Out of Airstream; rated and labeled according to UL 555 by an NRTL.
 - C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
 - D. Fire Rating: 1-1/2 and 3 hours (as required for wall rating).
 - E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
 - F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
 - G. Mounting Orientation: Vertical or horizontal as indicated.
 - H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
 - I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
 - J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
 - K. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F rated.
 - L. Provide an insulated duct access door at every fire damper location.
 - M. Provide an architectural access panel at all locations where access is not provided by others.

2.6 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

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. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

- B. Manufactured Turning Vanes for Metal Ducts: 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. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Single and Double wall.
- F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. McGill AirFlow LLC.
 - 4. Nailor Industries Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. 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: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
 - 1. Door and Frame Material: Galvanized sheet steel.
 - 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
 - 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

4. Factory set at 10-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.9 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Flame Gard, Inc.
 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.10 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 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.
- E. 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.
- F. 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. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.

- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.11 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
 4. Temperature Range: Minus 20 to plus 210 deg F.
- B. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 8-inch wg positive or negative.
 2. Maximum Air Velocity: 5000 fpm.
 3. Temperature Range: Minus 20 to plus 250 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- C. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.12 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.

2.13 LOUVERS

- A. Extruded Aluminum Stationary Louver with Horizontal Drainable Blades.
- B. Louvers shall be warranted against manufacturing defects for a period of 5 years.
- C. Louvers shall be licensed to bear the AMCA Certified Ratings label for Water and Air Performance.

- D. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.
- E. Manufacturers
1. All-Lite.
 2. Greenheck Fan Corporation.
- F. EXTERIOR HINGED Typical of All-Lite Model: EFD-637 (L-1 & L-2)
1. Construction:
 - a) Continuous hinge for 6"-deep aluminum louvers in openings up to 100" (2540) wide x 120" (3048) high.
 - b) Hinged louvers will be constructed as a double door.
 - c) Hinged louvers shall include an aluminum channel subframe (door frame) around the perimeter of the opening with an optional 1-1/2" sub-frame flange.
 - d) Hinged louvers will include a flanged frame to prevent the door from over-rotating through the opening.
 - e) Material: Mill Finish 6063-T5 extruded aluminum.
 - f) Frame: 6" deep x 0.081" thick (152 mm x 2 mm) channel. [flanged].
 - g) Blades: 37½° x 0.081" (2 mm) thick Horizontal drainable style.
 - h) Locking device: Steel hasp plate to accommodate field-supplied padlock
 - i) Mounting hardware: Optional aluminum clip angles or Continuous angles
 - j) Factory head and sill flashing with dams
 - k) Screen: ½" x 0.063" (12.7 mm x 1.6 mm) expanded and flattened aluminum birdscreen.
 - l) Mullion: Visible.
 2. Performance Data:
 - a) Based on testing 48 inch x 48 inch (1222 mm x 1222 mm) size unit in accordance with AMCA 500L.
 - b) Free Area: 59.4% nominal
 - c) Free area size: 9.5 ft² (0.88 m²)
 - d) Maximum Recommended Air Flow thru Free Area: 990 fpm (5.03 m/s).
 - e) Air Flow: 9,405 cfm (4.44 m³/s).
 - f) Maximum Pressure Drop: 0.11 in. wg. (27 Pa).
 - g) Water penetration: Maximum of 0.01 ounces per square foot (3.1 g/m²) of free area at an air flow of 990 fpm (5.03 m/s) free area velocity when tested for 15 minutes.
 3. Design Load:
 - a) Wind Load: Louver designs shall withstand the effects of 30 psf (1.44 kPa) of uniform pressure acting inward or outward.
 - b) Seismic Performance: Louvers, including attachments to other construction, shall withstand seismic effects determined by ASCE-7.
 4. Finish louvers after assembly as follows: Finish and custom color selected by Architect.
- G. INTERIOR FIXED Typical of All-Lite Model: EFJ-437 (L-3)
1. Construction:
 - a) 4"-deep aluminum louver.
 - b) Material: Mill Finish 6063-T5 extruded aluminum.
 - c) Frame: 6" deep x 0.081" thick (152 mm x 2 mm) channel, 1-1/2" flanged
 - d) Blades: 37½° x 0.081" (2 mm) thick Horizontal drainable style.
 - e) Screen: Indoor application, no birdscreen.
 - f) Mullion: Visible.

2. Performance Data:
 - a) Based on testing 48 inch x 48 inch (1222 mm x 1222 mm) size unit in accordance with AMCA 500L.
 - b) Free Area: 59.4% nominal
 - c) Free area size: 9.5 ft² (0.88 m²)
 - d) Maximum Recommended Air Flow thru Free Area: 990 fpm (5.03 m/s).
 - e) Air Flow: 9,405 cfm (4.44 m³/s).
 - f) Maximum Pressure Drop: 0.11 in. wg. (27 Pa).
 - g) Water penetration: Maximum of 0.01 ounces per square foot (3.1 g/m²) of free area at an air flow of 990 fpm (5.03 m/s) free area velocity when tested for 15 minutes.
3. Design Load:
 - a) Wind Load: Louver designs shall withstand the effects of 30 psf (1.44 kPa) of uniform pressure acting inward or outward.
 - b) Seismic Performance: Louvers, including attachments to other construction, shall withstand seismic effects determined by ASCE-7.
4. Finish louvers after assembly as follows: Finish and custom color selected by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," 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 dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts regardless of whether shown on the plans or not. 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.
 3. Do not install volume dampers upstream of variable air volume boxes (VAV).
- E. Set all dampers to fully open position during installation, before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. Upstream from duct filters.
 2. At outdoor-air intakes and mixed-air plenums.
 3. At drain pans and seals.
 4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

5. Adjacent to and close enough to fire or smoke dampers, and positioned to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors.
 6. Control devices requiring inspection.
 7. At Air-flow stations for inspection and cleaning of probes.
 8. Elsewhere as indicated.
- I. Access Door Sizes:
1. One-Hand or Inspection Access: 12 by 12 inches.
 2. Two-Hand Access: 16 by 12 inches.
 3. Head and Hand Access: 18 by 12 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 30 by 30 inches.
 6. Body plus Ladder Access: 42 by 30 inches.
- J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- K. Install fire proof, leak-proof access ports on grease duct.
1. Install in accordance with NFPA requirements.
 2. Install on sides of ducts to allow for inspection and cleaning. Do not install on the bottom of duct to avoid grease accumulation.
 3. Install at each change in direction and at maximum 20-foot spacing.
 4. Install upstream from wall or roof penetrations.
- L. Install flexible connectors to connect ducts to equipment.
- M. Do not use flexible duct work on terminal units, in concealed spaces, or to change directions. Maximum length of flexible duct is 6'. Secure at ends with a minimum of 3 screws and tape
- N. Connect diffusers or light troffer boots to ducts with MAXIMUM 60-inch lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands and screws.
- P. Install duct test holes where required for testing and balancing purposes.

3.2 LOUVERS

A. EXAMINATION

1. Examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. Clean Opening thoroughly prior to installation.
2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. INSTALLATION

1. Install louvers at locations as indicated on the drawings and in accordance with manufacturer's instructions.
2. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.
3. Install joint sealants as specified in Section 079000.

D. CLEANING

1. Clean exposed surfaces of louvers with water and mild soap or detergent not harmful to finish taking care to remove fingerprints and soil. Thoroughly rinse surfaces and dry. Do not let soil accumulate during construction period.
2. Touch-up, repair, or replace louvers damaged during installation and construction so that no evidence remains of the corrective work.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement and tight closure.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION

SECTION 23 81 26 - MULTI INDOOR UNIT VARIABLE REFRIGERANT FLOW

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Outdoor heat pumps operating with R-410A refrigerant (CU).
 - 2. Indoor ducted and ductless air handlers (IDU).
 - 3. Zone controllers.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, options, and accessories for each unit indicated in accordance with Section 230500.
- B. Shop Drawings:
 - 1. Manufacturer Piping and Diagrams and schematics from manufacturer specific software including specific equipment, pipe sizes, estimated piping lengths, and estimated refrigerant volume.
 - 2. Performance and capacity details of all units at specified indoor and outdoor conditions.
 - 3. Refrigerant charge per system including ASHRAE 15 analysis.
 - 4. 10-year parts only warranty information.
 - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Submittal shall include a copy of the installing contractor's certification of heat pump manufacturer approved training.
- D. Operation and maintenance data.
- E. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

1.3 QUALITY ASSURANCE

- A. The system and the design shall be in compliance with ASHRAE 15 Mechanical Refrigerant Code.
- B. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 2. All wiring shall be in accordance with the National Electric Code (NEC).
 - 3. The units shall be ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.
- C. All units shall be listed and rated by ANSI/AHRI Standard 1230-2010 and meet all minimum IEER performance requirements as scheduled.

- D. The units shall be ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials and workmanship within **two years** from date of Substantial Completion.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.
 - 2. Warranty Period for Control Boards: Manufacturer's standard, but not less than 3 years from date of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

- 1. All equipment shall be stored and handled according to the manufacturer's recommendation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi Electric
 - 2. Alternate manufacturers shall send approval requests to the CM and AOR 21-days prior to bid day. Include all information relevant to the alternate heat pump system, including but not limited to: unit selections, refrigerant piping layout, refrigerant charge with ASHRAE 15 analysis, branch selector box layout and locations, heating and cooling capacities at design temperatures and including capacity losses from piping lengths, defrost cycles, and combination ratios, dimensional and weight differences, and any other aspect of the system that differs from the system specified.

2.2 SYSTEM DESCRIPTION

- A. Heat Pumps:
 - 1. The system shall be a two-pipe heat pump system. The system is not a simultaneous heating and cooling heat recovery system.

2.3 OUTDOOR UNIT

- A. General: The outdoor unit shall be used specifically with matching manufacturer components. The outdoor units shall be equipped with multiple Simple MA controls that shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 - 1. Both refrigerant lines from the outdoor unit to the indoor unit shall be insulated in accordance with the installation manual.
 - 2. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 - 3. The outdoor unit shall be capable of operating in heating mode down to -13°F ambient temperature, without additional low ambient controls. If an alternate manufacturer is

- selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.
4. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
 5. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 6. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
- B. Unit Cabinet:
1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
- C. Fan:
1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
 2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 3. All fan motors shall be mounted for quiet operation.
 4. All fans shall be provided with a raised guard to prevent contact with moving parts.
 5. The outdoor unit shall have vertical discharge airflow.
- D. Refrigerant
1. R410A refrigerant shall be required for outdoor unit systems.
 2. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
- E. Coil:
1. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction.
 2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 3. The coil shall be protected with an integral metal guard.
 4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
 5. The outdoor coil shall include four circuits with two position valves for each circuit, except for the last stage.
- F. Compressor:
1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non-inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
 2. A crankcase heater(s) shall be factory mounted on the compressor(s).
 3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 15%-5% of rated capacity, depending upon unit size.
 4. The compressor will be equipped with an internal thermal overload.
 5. The compressor shall be mounted to avoid the transmission of vibration.

6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

G. Electrical:

1. The outdoor unit electrical power shall be 208/230, 1-phase, 60 hertz as noted on the plans.
2. The outdoor unit shall be controlled by integral microprocessors.
3. The control circuit between the indoor units, and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.4 CASSETTE-STYLE CEILING-MOUNTED UNITS

A. Manufacturers:

1. Mitsubishi/Trane Co. (The); Worldwide Applied Systems Group.

B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit T-bar ceiling opening of 24 by 48 inches.

C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch thick duct liner.

1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches, with filter.
2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.

E. Refrigeration System:

1. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
2. Refrigerant: R-410A.
3. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
4. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

F. Filters:

1. 1-inch thick, disposable, glass-fiber media, MERV-10 minimum (ASHRAE 52.2) in ceiling cassette units.

G. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature and humidity control modules, humidity contactor, time-delay relay, Heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.

2.5 FILTERS

- A. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with holding frames.
 - 1. Media: Interlaced glass-fibers sprayed with nonflammable adhesive in galvanized-steel frame.
 - 2. Ceiling Cassette Units (Administrative Areas): 1-inch thick, disposable, glass-fiber media, MERV-10 minimum (ASHRAE 52.2).
- B. Washable Panel Filters are not acceptable.
- C. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.6 ACCESSORIES

- A. Wired remote Simple MA control thermostat.
- B. Built-in condensate lift kit (pump).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The heat pump system shall be installed by a contractor with extensive installation and service training. The mandatory contractor service and installation training should be performed by the manufacturer.
- B. Install all equipment with clearance for service and maintenance.

3.2 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Provide factory start-up and set-up of review and adjustment of refrigerant charges/pressures/temperatures, field programmed options, communication with the manufacturer's controller. Verify start-up with a completed commissioning report submitted and approved by the heat pump manufacturer's Service Department
- A. Tests and Inspections:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Heat pump fan coil and outdoor units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. After startup service and performance test change filters.

3.4 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- 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 2 visits to Project during other-than-normal occupancy hours for this purpose.
- D. Perform the following field tests and inspections and prepare test reports:
 1. After installing completely, perform visual and mechanical check of individual components.
 2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Repair or replace malfunctioning units and retest as specified above.

3.5 OWNER TRAINING

- A. The Contractor shall provide 24 hours of Field Supervised and Video Recorded Training and 3 days of off-site Factory Training for 3 CPSED Staff members.

END OF SECTION

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS (Read these DIVISIONS carefully. For purposes of bidding, assume that all work of the DIVISION referenced is to be performed under that DIVISION unless specifically indicated therein to be performed under the ELECTRICAL DIVISION. Coordinate with all divisions to ensure a complete installation)
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - B. Temporary wiring for building construction - see DIVISION 1.
 - C. Cutting and patching - see DIVISION 17
 - D. Allowances – see DIVISION 1.
 - E. Alternatives - see DIVISION 1.
 - F. Excavation and backfilling - see DIVISION 31.
 - G. Concrete - see DIVISION 3.
 - H. Manholes and handholes - see DIVISION 3.
 - I. Magnetic door release - see DIVISION 8.
 - J. Access panels - see DIVISION 8.
 - K. Painting of all backboards (on all sides and edges before mounting); painting of panels (trims and doors - 2 coats before mounting); painting of exposed electrical raceways, boxes and fittings - see DIVISION 9.
 - L. Elevators - see DIVISION 14.
 - M. Sprinkler flow switches and gate valve switches - see DIVISION 21.
 - N. Temperature controls, temperature control wiring, interlock wiring, and boiler control wiring (except as indicated on the electrical drawings) - see DIVISION 23.
- 1.2 SUMMARY
- A. Section Includes:
 - 1. Work that applies to all sections of DIVISION 26.
 - 2. Temporary electrical wiring.
 - 3. Interruption of existing electric service.
 - 4. Concrete bases.
 - 5. Electrical equipment coordination and installation.
 - 6. Sleeves for raceways and cables.
 - 7. Sleeve seals.

8. Grout.
9. Common electrical installation requirements.
10. Removals (demolition) and relocations

1.3 DEFINITIONS

- A. Provide: Furnish and install.
- B. Wiring: Wire, raceways, boxes and fittings.
- C. EPDM: Ethylene-propylene-diene-terpolymer rubber.
- D. NBR: Acrylonitrile-butadiene rubber.

1.4 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. Do all wiring and provide all equipment in accordance with the prevailing issue of the National Electrical Code, State Building Code, State Fire Code, OSHA and any additional local rules or requirements.
- C. Obtain and pay for all necessary permits, certificates, etc. Present satisfactory proof of final inspection and approval by all inspection authorities.
- D. Consider the following Industry Standards as minimum requirements for all materials, equipment and systems where such standards are established for materials in question:
 1. National Board of Fire Underwriters
 2. National Electrical Manufacturers Association
 3. National Fire Protection Association
 4. Institute of Electrical and Electronic Engineers
 5. Local Electric Utility Company
 6. Local Telephone Company
 7. A nationally recognized testing laboratory (UL, ETL, etc.)
 8. Factory Mutual
 9. Americans with Disabilities Act
- E. Where applicable, this installation shall comply with the following NECA (National Electrical Contractors Association) "National Electrical Installation Standards." Except, if there is a conflict between this specification and these standards, the requirements of this specification shall prevail.

1.	NECA 1-2000	Standard Practices for Good Workmanship in Electrical Contracting
2.	NECA 101-2001	Standard for Installing Steel Conduit (Rigid, EMT)
3.	NECA/AA 104-2000	Recommended Practice for Installing Aluminum Building Wire and Cable

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|----|---------------------|--|
| 4. | NECA 400-1998 | Recommended Practice for Installing and Maintaining Switchboards |
| 5. | NECA/EGSA 404-2000 | Recommended Practice for Installing Generator Sets |
| 6. | NECA/IESNA 500-1998 | Recommended Practice for Installing Indoor Commercial Lighting Systems |
| 7. | NECA/IESNA 501-2000 | Recommended Practice for Installing Exterior Lighting Systems |
| 8. | NECA/IESNA 502-1999 | Recommended Practice for Installing Industrial Lighting Systems |

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Services: All shutdowns of services (power, fire alarm, telephone, etc.) must be approved in writing by the Owner. 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 and Owner no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary service.
 3. Do not proceed with interruption of any service without Construction Manager's written permission. All "shutdowns" must be done at other than normal working hours without additional compensation.
 4. Pay all utility charges related to "shutdowns", if any.
 5. All building services (power, fire alarm, telephone, lighting, emergency lighting, exit signs, etc.) must remain in operation during full period of construction. Provide temporary or permanent wiring (if required) to accomplish this.
 6. When an existing fire alarm system is modified or replaced with new, all existing devices must remain in operation until replaced with new devices that are fully tested, approved and operational. All non-functioning equipment shall be so labeled until it is removed or put into service.
- B. Comply with NFPA 70E.

1.6 COORDINATION

- A. 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 and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. 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 08 Section "Access Doors and Frames."
 - D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07.
 - E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment that requires positioning before closing in the building.
 - F. Coordinate electrical service connections to components furnished by utility companies.
- 1.7 TEMPORARY ELECTRICAL WIRING: (Extended from existing building)
- A. Provide temporary electrical wiring of power and lighting for construction.
 - B. Extend service from the electrical system of the existing building. However, if it is necessary to disrupt the existing service, provide new temporary service or generator. Do not overtax the service or distribution system. Provide a portable generator, if necessary.
 - C. The Owner to pay the cost of energy consumed.
 - D. The General Contractor to pay for the cost of energy consumed. Provide a three-phase check meter connected to serve all temporary wiring. Meter reading at start and finish of construction shall be recorded in the presence of a representative of the Owner.
 - E. The existing service is 277/480 volts, 3 phase, 4 wire. 120/208 volts is available via step down transformer(s).
 - F. Provide all required connections, panels, circuit breakers, feeders, branch circuit wiring, transformers, lighting fixtures, lamps, receptacles, switches, etc. for a complete and operating temporary electrical system.
 - G. Provide a minimum of 10 footcandles of temporary general illumination throughout the floor area of the building, including all corridors and stairways.
 - H. Existing lighting may be used where it is sufficient and remains energized.
 - I. Provide feeders of sufficient capacity for the requirements of the work, sufficient number of outlets conveniently located so that extension cords not exceeding 100 feet will reach all work requiring artificial light or power.
 - J. All receptacles must be GFCI protected and the entire installation must comply with all applicable OSHA requirements.
 - K. At the end of the day's work, disconnect all lights and power, other than the minimum required security illumination.
 - L. Provide replacement light bulbs and maintenance of the temporary wiring system, as required, throughout the period of construction.
 - M. Conform to all codes and regulations.

- N. Completely remove temporary wiring system upon completion of construction.

1.8 CHANGE ORDERS/PROPOSAL REQUESTS:

- A. During the course of construction, changes in the work may occur. When a significant change is to be made, a Proposal Request will be issued.
- B. Provide a complete cost breakdown when responding to each Proposal Request.
- C. Each item of work to be priced separately.
- D. Each line item to be broken down including quantities and listing separately labor and material.
- E. Both credits and extras shall be separately and clearly quantified.
- F. Allowances for overhead and profit shall be as listed in the supplementary conditions.
- G. If you become aware of a field condition, code requirement, error, or omission that you feel should result in a change to the work, please contact the Engineer for discussion. The Engineer may be able to clarify the situation and avoid unnecessary paperwork.
- H. It is recognized that the Owner benefits when the construction process is a cooperative effort instead of an adversarial relationship. Reasonable give-and-take allows the construction process to move smoothly. Your efforts in this regard will be appreciated by all parties.

1.9 PACKAGED PRICES:

- A. It is in the facility owner's interest, that all bidders receive the best possible quotes on all materials during bidding so that any savings can result in a lower bid price. It is the policy of this Engineer not to specify brands that will result in "packaged" prices. Therefore, manufacturers' representatives are hereby notified that "packaged prices" are prohibited on this project. Upon request, suppliers are to provide bidders with complete material breakdown including each lighting fixture, system, component of system, each piece of equipment, etc. In keeping with this policy, Contractors are hereby cautioned not to anticipate deep discounts after the contract is awarded.

1.10 INSPECTIONS/SITE OBSERVATIONS

- A. The authority having jurisdiction (usually the Municipal Electrical Inspector) shall be notified at periodic intervals that an inspection is requested. Inspections shall be requested at points of progress, meeting the approval of the inspector and as a minimum include the following:
 - 1. Prior to enclosing walls.
 - 2. Prior to enclosing ceilings.
 - 3. Prior to installation of panel/switchgear trims/covers.
 - 4. For observation of connections and grounding at switchboards, transformers and generators.
- B. Do not cover the work before the Engineer has had a chance to observe it in completed form. The electrical foreman shall request a meeting with the Engineer within 10 days after the start of electrical construction to assure that there is agreement on the scope of work and to answer questions.

- C. The electrical foreman shall provide assistance to the Engineer during site observations:
1. Describe the progress of the electrical work in detail.
 2. Accompany the Engineer on his tour of the site, upon request.
 3. Provide use of a suitable ladder, scaffolding or bucket truck to observe the work, upon request.
 4. Remove ceiling tiles, panel trims, junction box covers, etc. for observation of the work, upon request.
 5. Provide use of project drawings, specifications and shop drawings.

1.11 GUARANTEES/WARRANTIES:

- A. See other portions of the Project Manual for details on Guarantees and Warranties. However, minimum shall be one year from date of acceptance by the Engineer.
- B. The Owner reserves the right to make appropriate modifications or extensions of systems and equipment furnished under this contract during the guarantee/warranty period without "voiding" or modifying the guarantee/warranty of equipment and wiring installed under this contract. If manufacturer voids guarantee, it shall not relieve this contractor of his responsibilities for guarantee/warranty period.

1.12 MISCELLANEOUS

- A. Provide all systems complete. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both.
- B. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.
- C. All wiring and connections shall be executed with associated circuit de-energized.

PART 2 - PRODUCTS

2.1 MATERIALS - General:

- A. All materials and equipment shall be new unless specifically stated otherwise.
- B. Materials and equipment shall be suitable for their intended use and for the environment in which they are installed. For example, equipment located outside shall be weatherproof and constructed of materials that will not rust. This includes brackets, screws, etc.
- C. Coordinate all dimensions to make sure that boxes, raceways, equipment, fixtures, etc., fit properly in the finished construction. If special provisions, such as shallow boxes, are required, they shall be provided at no increase in contract price, regardless of catalog numbers listed in contract documents or on shop drawings.
- D. As it is not practical to enumerate in these specifications (or show on the drawings) all details of fittings and accessory equipment required for proper operation of the various electrical systems herein described, it is understood that they will be supplied without extra compensation. Provide

all fittings, terminations, relays, components of panels and equipment, etc., needed for the best performance possible at the present state-of-the-art.

2.2 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- D. 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.
- E. 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.
- F. Right of Way: Give to piping systems installed at a required slope.
- G. Record of Addenda and Change Orders: To avoid overlooking addenda and change order modifications, mark all changes on all copies of drawings and specifications, in a manner acceptable to the Engineer. One method of accomplishing this is to make copies and tape them on the back of the preceding page (tape all edges). Also, circle the changed area and note: see addenda #1, etc. If whole pages or sheets change, either remove the superseded document or put a bold "X" through it.
- H. Record Drawings: Owner's record drawings shall be updated as the project progresses. Maintain documents in a safe, dry location. Indicate clearly and accurately any changes necessitated by field conditions and dimension all raceways built into or under concrete slabs or buried under ground. Contractor to prepare as-built drawings in CAD format at contractor's expense. Contract drawings in CAD format to be furnished to contractor at no cost to contractor. Contractor to provide two compact discs and two hard copies of final as-built drawings.

- I. Operating Instructions and Manuals: Provide the Owner or his representative with complete operating instructions by qualified personnel of all electrical systems. Provide three (3) bound sets (indexed and bound in three sturdy three-ring binders) of operating and maintenance instructions of all electrical systems employed and all shop drawings.
- J. Letter of Confirmation: Include in the above manuals a letter confirming that the following items have been completed. Provide written receipt signed by the Owner or his representative indicating that the first 4 items listed below have been received.
 - 1. The number of circuit breaker locks called for have been provided.
 - 2. Keys have been provided for all locked electrical equipment.
 - 3. The provisions of the "Operating Instructions and Manuals" paragraph of these specifications have been met.
 - 4. Spare fuses have been provided.
 - 5. A TV set matching cable has been provided for each outlet plus spares as called for.
 - 6. The lightning protection system "Master Label" has been provided.
 - 7. A nurse call cord has been provided for each station outlet plus spares as called for.
 - 8. Identification is complete and in accordance with these specifications.
 - 9. As-built electrical drawings have been completed and submitted.
 - 10. All tests are complete and in accordance with these specifications.
 - 11. All required shop drawings have been submitted and approved.
 - 12. The entire installation has been accepted by all authorities.

3.2 SEQUENCE AND BALANCE:

- A. Maintain correct phase sequence of all feeders and circuits by establishing phase identification and maintaining correct relationship throughout the system. Provide line balance within 10% of normal loads.

3.3 LAYOUTS

- A. The electrical system layouts indicated are generally diagrammatic and locations of outlets and equipment are approximate only; govern exact routing of wiring and locations of outlets and equipment by structural conditions and obstructions. This is not to be construed to permit redesigning systems. Interconnect as shown.
- B. Locate all equipment requiring maintenance and operation so that it will be readily accessible. The right is reserved to make any reasonable change in location of outlets and equipment prior to roughing-in without involving additional expense. This may involve slightly longer wiring runs, longer stems, additional mounting provisions, etc. Allow for this in your bid because additional compensation will not be provided. Items not specifically located on the plans shall (for the purposes of bidding) be assumed to be in the farthest, most difficult location. Exact location to be as directed in the field.

3.4 ELECTRICAL SERVICE: (Existing)

- A. Existing electrical service shall remain.

- 1. Service voltage is 277/480 volts, three phase, four wire.

3.5 Conform to all requirements of the local electrical utility company, municipality and state

3.6 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable (unless sleeve seal is to be installed), unless seismic criteria require different clearance, or indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry, and with approved joint compound for gypsum board assemblies.
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with firestopping requirements in Division 07.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.7 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07.
- B. Penetrations through exterior surfaces shall be made watertight.
- C. Floor boxes, fed from floor below, shall be fire-rated, poke-through type with UL labeled fire rating to match floor rating.

3.8 WORK INTERFERING WITH EXISTING WIRING:

- A. Make any necessary re-circuiting, extensions of existing circuits and relocations required to properly re-energize remaining existing devices or equipment that may be interfered with by new construction or removals.

3.9 REMOVALS (DEMOLITION) AND RELOCATIONS:

- A. Coordinate with DIVISION 2 section "Selective Demolition."
- B. Do all removal work in a neat and orderly manner so as not to endanger lives nor cause damage. Removal work to include all associated hangers, couplings, supports, raceway and wiring, etc., and shall be complete in every way.
- C. Remove and dispose of, off-site in a legal manner, all raceways and wire indicated to be removed.
- D. Carefully remove and store on-site, where directed by the Owner, all electrical equipment indicated to be REMOVED. After the Owner has examined this equipment, remove and dispose of, off-site in a legal manner, all of this equipment that the Owner does not want. All remaining equipment shall remain the property of the Owner. Relocate the remaining equipment to a permanent storage location on site where directed by the Owner.
- E. The electrical removal (demolition) drawings show the general extent of removals. However it is impractical to show every item; some of which may be concealed. Therefore, assume that you will be required to perform an additional 10% of removal work, without additional compensation. Items not shown to be removed or to remain shall remain or be removed, as directed.
- F. Prior to removing any electrical equipment, properly de-energize all associated wiring. Remove wires from terminals of supply switches or circuit breakers. Properly tape supply and load end conductors of all wiring remaining and not re-used. Properly tag both ends.
- G. Provide outlet boxes, knock-out seals, receptacle cover plates, etc. to leave remaining installation in finished condition.
- H. Take special care in removing equipment indicated to be RELOCATED and properly and thoroughly clean and lubricate this equipment. Renew fuses and overload elements in starters and switches being relocated, if required to properly serve the new installation.
- I. Adjust outlet and junction boxes as required to suit new finished surfaces.

- J. When necessary to perform your work, carefully remove ceiling tiles and properly re-install them. Make sure that hands are clean and take special care to avoid damage. If tiles become damaged, provide new tiles to exactly match existing. If exiting tiles have yellowed with age, it may be necessary to relocate existing undamaged tiles from utility spaces (closets, etc.) and install new tiles in their place.
- K. For relocation of lighting fixtures, see sections entitled "Interior Lighting" and "Exterior Lighting."
- L. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- M. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- N. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- O. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.10 CUTTING AND PATCHING

- A. This trade (specification section) is responsible for its respective cutting and patching.
- B. Do not endanger any work by cutting or altering work or any part of it.
- C. Do not cut or alter work of another Contractor without written consent of the Engineer.
- D. Prior to cutting which affects structural safety of project, or work of another Contractor, submit written notice to the Engineer, requesting consent to proceed with cutting.
- E. Perform all work of fitting, adjustment, cutting, patching, finishing and restoration to perfectly match the quality as specified throughout these specifications. Painting shall match and be feathered into adjacent surfaces.

3.11 CORE DRILLING:

- A. All holes through masonry surfaces must be "core drilled". This trade (specification section) is responsible for its respective core drilling, if any.
- B. Do not endanger any work by drilling or altering work or any part of it.
- C. Do not drill or alter work of another Contractor without written consent of the Engineer.
- D. Prior to drilling which affects structural safety of project, or work of another Contractor, submit written notice to the Engineer, requesting consent to proceed with cutting.
- E. Perform all work of core drilling to perfectly match the quality as specified throughout these specifications.

3.12 ACCESS PANELS:

- A. This trade (specification section) is responsible for determining the number of access panels required for existing and new electrical work (including one under each above ceiling thermodetector) and furnishing them to the mason or drywall contractor for installation. See DIVISION 8.

3.13 CLEANING, PAINTING AND REFINISHING:

- A. Paint all new plywood backboards on all sides and edges before mounting.
- B. Thoroughly clean all new electrical equipment, devices and enclosures upon completion of all work.
- C. Refinish any new electrical equipment whose finish is damaged or rusted, as determined by the Engineer.

END OF SECTION 260500

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600V-COPPER ONLY)

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. Specification Section 260500 Common Work Results For Electrical.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 - 1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.
 - 2. Division 26 Section "Undercarpet Electrical Power Cables" for flat cables for undercarpet installations.
 - 3. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability 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.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- 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 NFPA 70.

1.6 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Alcan Products Corporation; Alcan Cable Division.
 2. American Insulated Wire Corp.
 3. General Cable Corporation.
 4. Southwire Company.
 5. Equal approved by Engineer.
- B. All conductors, insulation, and cables shall comply with NEMA WC 70.
- C. Conductor Material: Copper complying with NEMA WC 5 solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- D. Conductor Insulation Types: Type THHN-THWN or XHHW complying with NEMA WC 5.
- E. Multiconductor Cable: Metal-clad cable, Type MC.

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 1. AFC Cable Systems, Inc.
 2. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.
 6. Equal approved by Engineer.
- B. Description: Spring-type factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C. Do not use push-in type wire connectors, use spring type instead.

2.3 SLEEVES AND SLEEVE SEALS: See Specification Section 260500/2.1 & 2.2.

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.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway, Type XHHW, single conductors in raceway, or, Type SE or USE multiconductor cable. See One-Line Diagram.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway, or Mineral-insulated, metal-sheathed cable, Type MI.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- F. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- G. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway, or Mineral-insulated, metal-sheathed cable, Type MI.
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- J. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.

- K. Branch Circuits in Cable Tray: Type THHN-THWN, single conductors in raceway, Metal-clad cable, Type MC, or Mineral-insulated, metal-sheathed cable, Type MI.
- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- M. Fire Alarm Circuits: see FIRE ALARM SECTION.
- N. Health Care Facilities: (For branch circuits concealed in ceilings, walls and partitions); Type THHN-THWN, single conductors in raceway; Metal-clad cable, Type MC; or 90 degree C Type ACTHH cable. Except, do not use Type MC cable in "Patient Care Areas".
- O. Isolated Grounds: Do not use armor of Type MC cable for ground, for Power Quality reasons. Use of MC cable with two (2) insulated ground wires is acceptable.
- P. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- Q. Class 2 Control Circuits: Type THHN-THWN, in raceway, Power-limited cable, concealed in building finishes, or Power-limited tray cable, in cable tray.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. 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. Confirm conduit ID and that conduit will be at or below 40% filled. Confirm jam ratios and take precautions when pulling.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- 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. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- G. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- H. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.
- I. Where the number of current-carrying conductors in a raceway or cable exceeds three, the allowable ampacity shall be reduced per NEC table based on no diversity. Consider neutrals to be current carrying conductors.

3.4 CONNECTIONS

- A. Make all final connections required for a complete and fully operational facility.

- B. Wiring connections to equipment shall include connections to all accessories. For example, if a fan has an associated damper, the wiring must be extended from the fan to the damper at no additional charge. Another example is interconnection of equipment. Some items of equipment consist of several pieces, which must be interconnected before connecting to the circuit. No additional compensation will be paid for interconnections.
- 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 and UL 486B.
- D. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- E. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.
- F. Locations of junction boxes, stub-ups and disconnects are diagrammatic. At the time of design, the exact brand of equipment is usually not known. Therefore, the exact locations of connections are not known. For the purposes of bidding assume the worst, farthest locations. During construction, coordinate connections with final approved shop drawings and coordinate with other trades. Conform to manufactures written installation instructions. Provide working space in compliance with code.

3.5 FIELD QUALITY CONTROL

- A. All cables installed under this contract are to be protected from damage prior to installation, during installation, and after installation. Store cable in a dry area protected from physical damage. Before installing cable, raceway shall be clear, dry and free from burrs or sharp edges. When cables pass through metal partitions, provide permanently installed insulating bushings; this applies to all cables installed under this contract (systems, communications, etc.). Insulated bushings are to be installed prior to pulling in of cable. Cables shall be installed back from edge of studs as required by Code.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Perform tests and inspections and prepare test reports.
- D. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance conductors, all feeder conductors, and conductors #8AWG and larger for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Consider the cost and benefit of infrared scanning of cable and conductor splices before retaining subparagraph and associated subparagraphs below.
 - 4. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

- b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare and provide to Owner and Engineer a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E. Test Reports: Prepare and provide to Owner and Engineer a written report to record the following:
- 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- F. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 methods and materials for grounding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Common ground bonding with lightning protection system.

1.3 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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 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. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
- C. 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.
- D. 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.

3.3 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. 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 so vibration is not transmitted to rigidly mounted equipment.

END OF SECTION 260526

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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 the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
 - 1. Division 26 Section "Vibration and Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Metallic slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.7 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.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs. Strength rating to suit structural loading. Comply with MFMA-4, factory-fabricated components for field assembly.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - h. Equal approved by Engineer.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

- a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - e. Equal approved by Engineer.
2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers. As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron with hot-dip galvanized finish..
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 5) Equal approved by Engineer.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

- 5) MKT Fastening, LLC.
 - 6) Equal approved by Engineer.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 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 Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) 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. Support individual horizontal single raceways with separate, malleable-iron pipe hangers or clamps except use spring-steel fasteners for 1-1/2-inch (38-mm) and smaller single raceways above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

- E. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads (+25 percent minimum) within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- F. 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 (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 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 meet seismic-restraint strength and anchorage requirements.
 - 9. Fasteners: Select so load applied to each fastener does not exceed 25 percent of its proof-test load.
- G. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "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 (100 mm) 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 (20.7-MPa, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete (Limited Applications)."
- C. Anchor equipment to concrete base.

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 (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections 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 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.
- J. RGS: Rigid galvanized steel conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways, fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.

- d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.
- C. Coordination Drawings: Conduit routing plans, 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. Structural members in the paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.
- D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal 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 cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, 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 professional engineer and testing agency.
- F. Source quality-control test reports.
- 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.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 5. Electri-Flex Co.
 - 6. Manhattan/CDT/Cole-Flex.
 - 7. Maverick Tube Corporation.
 - 8. O-Z Gedney; a unit of General Signal.

9. Wheatland Tube Company.
 10. Equal approved by Engineer.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- F. EMT: ANSI C80.3.
- G. FMC: Zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 2. Fittings for EMT: Steel, set-screw type.
 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.; Pipe & Plastics Group.
 6. Condux International, Inc.
 7. ElecSYS, Inc.
 8. Electri-Flex Co.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT/Cole-Flex.
 11. RACO; a Hubbell Company.
 12. Thomas & Betts Corporation.
 13. Equal approved by Engineer.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

- D. LFNC: UL 1660.
- E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- F. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Arco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products.
 - 5. Equal approved by Engineer.
- B. Description: Comply with UL 2024; flexible type, approved for plenum, riser, or general-use installation, as needed.

2.4 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
 - 4. Equal approved by Engineer.
- C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, 12, or 3R, as indicated or required by environmental conditions.
- D. Fittings and Accessories: Include 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.
- E. Wireway Covers: Hinged type, screw-cover type, or flanged-and-gasketed type, as indicated.
- F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Hoffman.
 - 2. Lamson & Sessions; Carlon Electrical Products.
 - 3. Equal approved by Engineer.
- B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with

captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Fittings and Accessories: Include 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.

2.6 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
 - d. Equal approved by Engineer.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell Company.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet Division.
 - 10. Spring City Electrical Manufacturing Company.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
 - 14. Equal approved by Engineer.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- I. Hinged-Cover Enclosures: 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.
- J. 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.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
 - 1. Color of Frame and Cover: Green.
 - 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, as indicated for each service.
 - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 7. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
 - e. Equal approved by Engineer.

2.9 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section on penetration firestopping.

2.10 SLEEVE SEALS

1. See Section 260500.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Rigid steel conduit.
 2. Concealed Conduit, Aboveground: EMT.
 3. Underground Conduit, over 600 volts: RNC, Type EPC-80-PVC, direct buried.
 4. Underground Conduit, under 600 volts: RNC, Type EPC-40-PVC, direct buried.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): In dry conditions, use FMC. Use LFMC in damp, wet, or dirty conditions.
 6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or 4, as indicated.
 7. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed and Subject to Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Per drawings.

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, wet, or dirty locations.
 5. Damp or Wet Locations: Rigid steel conduit.
 6. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
 7. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
 8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in corrosive locations.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- 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.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits in contact with concrete.
- 3.2 INSTALLATION
- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 12 inches (300 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
1. Run conduit larger than 2-inch (54-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 2. Arrange raceways to cross building expansion joints at right angles; with expansion fittings.

3. Change from Type EPC-40-PVC, to rigid steel conduit before rising above the floor.
- I. 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.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors of all sizes.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
 2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated or heated spaces.
 2. Where otherwise required by NFPA 70.
- N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
 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 the time of installation.

- O. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject.
- P. 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.
- Q. Set metal floor boxes level and flush with finished floor surface.
- R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

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 Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
 - 2. Install backfill as specified in Division 31 Section "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 (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 - 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 - 5. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line; or 40 inches below grade.

- E. 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 the enclosure.
- F. Field-cut openings for conduits 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.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. See Section 260500.

3.6 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Identification for busway and raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- 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. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on a yellow field.
 - 2. Legend: Indicate voltage.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on a yellow field.
 - 2. Legend: Indicate voltage.
- C. Indoor: Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Outdoor: Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.5 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Underground Warning Tape (minimum): Permanent, bright-colored, continuous-printed, vinyl tape compounded for permanent direct-burial service, and with the following features:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side, compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145, Chapter XVII. Colors, legend, and size appropriate to each application.

1. Interior Units: Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
2. Exterior Units: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with 0.0396-inch (1-mm), galvanized-steel backing. 1/4-inch (6-mm) grommets in corners for mounting.

B. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

C. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

3. The above are sample warning labels. Specific warning labels shall be determined by the Electrical Contractor.
4. Electrical Contractor shall provide additional warning signs as required by the local AHJ.
5. Provide additional signage as requested by owner, maintenance and safety personal.

2.8 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 1. Engraved legend with white letters on black face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- B. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background, unless otherwise indicated. Minimum letter height shall be 3/8 inch (10 mm).

2.10 CABLE TIES

- A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select 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 INSTALLATION

- A. Verify identity of each item before installing identification products.

- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.
- I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Busway, Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 30-foot (10-m) maximum intervals.
- B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.
- C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Optional Standby Power.
 - 2. Power.
 - 3. Fire Alarm.
 - 4. Low Voltage.
 - 5. UPS Power.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

- a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White
 - 5) Ground: Green
 - 6) Isolated Ground: Green w/trace ID
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray
 - 5) Ground: Green
 - 6) Isolated Ground: Green w/trace ID
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- F. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive or mechanical fastened warning labels. For outdoor equipment, weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with 0.0396-inch (1-mm), galvanized-steel backing. 1/4-inch (6-mm) grommets in corners for mounting.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. 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.
 - c. Storm switches.
 - d. Generator docking stations.
- L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- M. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer, load shedding, kirk key operation.
- N. At each pull box, junction box and outlet box, each circuit contained therein shall be identified by panel designation and circuit number. This shall be accomplished by attaching hand written cardboard labels with string to each set of wires or by other agreed upon methods. In addition, where boxes are concealed, covers shall be marked with the same information using magic marker or other agreed upon means.
- O. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, Stenciled legend 4 inches (100 mm) high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Information shall include circuit numbers, type of load served and location of load served. For example: #1 Receptacles in rooms 5 & 6. Panelboard identification shall be engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Access doors and panels for concealed electrical items.
- d. Switchboards.
- e. Enclosed switches.
- f. Enclosed circuit breakers.
- g. Enclosed controllers.
- h. Variable-speed controllers.
- i. Push-button stations.
- j. Contactors.

END OF SECTION 260553

SECTION 26 09 37 – ELEVATOR ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes electrical work related to the work of Division 14.

1.2 RELATED DOCUMENTS

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all **ELEVATOR ELECTRICAL PROVISIONS** work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Wiring and connection diagrams.

1.4 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.

PART 2 - PRODUCTS

2.1 ELEVATOR ELECTRICAL PROVISIONS

- A. A lockable fused disconnect switch or circuit breaker in elevator machine room with 120 volt supply for cab lights.
- B. Light and GFCI convenience outlet in pit with light switch located adjacent to the access door.
- C. Light and GFCI convenience outlet in machine room with light switch located within 18" of lock jamb side of door.
- D. For each elevator, a fused disconnect switch located near the machine room door with wiring to each elevator controller. Provide interlock in disconnect for emergency power lock-out.
- E. A 120 volt, 20 amp, single phase feed to each controller.

- F. A 120 volt circuit for oil heaters (if hydraulic).
- G. J.B. in elevator machine room with 3/4" conduit to telephone backboard for cab telephone.
- H. Three fire alarm control modules for elevator capture and firefighters hat light.
- I. Emergency power is serving the elevator. Provide the following:
 - 1. Automatic transfer of all elevator feeders to the emergency source.
 - 2. Auxiliary normally closed contact (closed when in normal power position/open when in emergency power position) on the automatic transfer switch for elevator emergency control.
 - 3. Auxiliary normally closed contact (open upon initiation of power transfer and to close when transfer is complete) on the automatic transfer switch for elevator emergency control.
 - 4. Automatic transfer switch shall have an inhibit function which will delay transfer to normal and/or emergency power by an adjustable period of 0-300 seconds.
 - 5. Automatic transfer switch shall have a phase monitor feature, which prohibits the transfer of power between "live" sources unless the sources are in phase with each other.
 - 6. If the sprinkler shaft is sprinklered due to combustible shaft construction, provide shunt trip accessories to the circuit breaker serving the elevator control panel. Also provide additional auxiliary normally closed contact on the automatic transfer switch for elevator emergency control.
 - 7. Provide 2#12+1#12G wires in 3/4" conduit from the automatic transfer switch to each of the elevator controllers in the elevator machine room (to prevent all but one elevator from running at once).
 - 8. For each set of contacts indicated above provide 2#12+1#12G wires in 3/4" conduit from the automatic transfer switch to each of the elevator controllers in the elevator machine room.
 - 9. The requirements above may vary and is dependent on specific elevator vendor requirements for the project specific installation. The electrical contractor shall coordinate with the elevator vendor and provide all necessary automatic transfer switch features and wiring and conduit between elevator controller(s) and the associated automatic transfer switch serving them.
 - 10. If the elevator produces elevator regenerative power and is not also wired to other emergency loads to absorb the regenerative power, then provide a regenerative resistor to absorb the elevator created regenerative power to prevent motoring of the emergency generator.
- J. If the selector switch is not located on the hoistway wall, provide four #14 wires in 1/2" conduit to the elevator machine room (where elevators are located in separated areas.)
- K. When the elevator controllers are not located in the common machine room, provide the following:
 - 1. Eight #14 wires in 3/4" conduit between elevator controllers.
- L. For high-rise buildings, provide a 2-inch raceway between elevator controller and Elevator Fire Station Panel (located at the fire control center).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide wiring according to Division 26, Section "Conductors and Cables".
- B. Provide raceways according to Division 26, Section "Raceways and Boxes".
- C. Provide grounding according to Division 26, Section "Grounding Bonding & Surge Protection Devices".
- D. Comply with requirements of elevator vendor and elevator inspector.

END OF SECTION 260937

SECTION 26 24 20 – MECHANICAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Electrical work relating to the work of Division 22 “PLUMBING” and Division 23 “MECHANICAL”.

1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all PLUMBING AND MECHANICAL ELECTRICAL REQUIREMENTS work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Wiring and connection diagrams.

1.4 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufactures listed.

2.2 HVAC & PLUMBING

- A. Provide all wire, conduit, boxes and fittings for all HVAC and plumbing equipment and final connections. Conform to Division 26, Section “Conductors and Cables”.
- B. Examine DIVISION 22 and 23 carefully for any work specified as performed under this Section and coordinate.
- C. Provide all disconnects according to Division 26, Section “Enclosed Switches and Circuit Breakers”.

- D. Provide nameplates on all disconnects according to Division 26, Section "Basic Materials and Methods".
- E. Automatic starters and manual starters (thermal toggle switches) that are to be furnished under DIVISION 22 and 23 are assumed to be shipped loose, install and wire (both sides) under this Section. Some starters may be variable frequency drive (VFD) type and may have built-in disconnects. Provide wiring on both sides. Some VFD's are large and heavy. Provide adequate mounting support and proper working space.
- F. Provide a manual starter (thermal toggle switch) at each single phase motor not furnished with an automatic starter. Manual starters to consist of a manual operated toggle switch equipped with a melting alloy type thermal overload relay. Starters must be inoperative if thermal unit is removed. Mount at motor location.
- G. Provide an automatic magnetic starter for each three phase motor not furnished with an automatic starter as required to suit the load and control strategy.
- H. Temperature controls are provided under DIVISION 23. Temperature control wiring, interlock wiring, and boiler control wiring are provided under DIVISION 23, except as shown on the electrical drawings or indicated differently herein.
- I. Install and wire to electric heating units furnished under DIVISION 23.
- J. Provide power wiring to all control transformers and temperature control panels.
- K. Control valves and transformers for all heating units are furnished and installed under DIVISION 23.
- L. Do not use electrical drawings for location of feeds to mechanical equipment. In general, use mechanical drawings for bidding purposes and final approved mechanical shop drawings for actual installation. However, report any discrepancies to mechanical and electrical engineer for final determination, prior to installation.
- M. Wire all miscellaneous circulation and condensate pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install according to NEMA standards.
- B. Mount plumb and rigid without distortion of box.
- C. Provide supports and nameplates, according to Division 26 section "Basic Electrical Materials and Methods".
- D. Ground according to Division 26, Section "Grounding, Bonding & Surge Protective Devices".
- E. Provide wiring according to Division 26, Section "Conductors and Cables".
- F. Provide raceways according to Division 26, Section "Raceways and Boxes".

END OF SECTION 262419

SECTION 26 27 26 - WIRING DEVICES

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 the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Snap switches and wall-box dimmers.
 - 3. Wall-switch sensors.
 - 4. Cord and plug sets.
 - 5. Device trim plates.
 - 6. Emergency lighting relays.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: Include all manufacturers' packing label warnings and instruction manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

- 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 NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
- B. Provide additional receptacles to suit the particular equipment served.
- C. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wiring Devices:
 - a. General Electric Company
 - b. Bryant Electric, Inc./Hubbell Subsidiary.
 - c. Hubbell Incorporated; Wiring Device-Kellems.
 - d. Leviton Mfg. Company Inc.
 - e. Pass & Seymour/Legrand; Wiring Devices Div.
 - f. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper)
 - 2. Multioutlet Assemblies:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Wiremold Company (The).
 - c. Equal approved by Engineer.

2.2 RECEPTACLES

- A. General
 - 1. Comply with NEMA WD 1, NEMA WD 6, and UL 498.
 - 2. Provide additional receptacles to suit the particular equipment served.
 - 3. Provide other special duty receptacles as indicated on the drawings.
 - 4. Receptacles mounted outdoors or in other wet or damp locations shall be GFI type and installed in weatherproof enclosures, the integrity of which is not affected when the receptacle is in use (attachment plug cap inserted). Also comply with UL 943, Class A, and include indicator light that is lighted when device is tripped.
 - 5. Color as selected by Architect, or as noted.
 - 6. Catalog numbers are for General Electric Company, or as noted.
 - 7. Isolated-Ground, Duplex Convenience Receptacles: Straight blade; equipment grounding contacts shall be connected only to the 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.
- B. Provide 20 amp. commercial specification grade, grounded, DUPLEX RECEPTACLES.

20A/125V	Duplex Receptacle	GE #GCR-20
20A/125V	Single Receptacle	GE #4102
30A/125V/250V	4 Wire Receptacle	GE #1439-3
50A/125V/250V	4 Wire Receptacle	GE #4181-3
20A/125V	Duplex Receptacle	GE #5362-IG (Isolated Ground)
20A/125V	Single Receptacle	GE #4102-IG (Isolated Ground)
20A/125V	GFI Dup. Rec.	GE #GFR 5342

- C. Provide Wiring Devices for HAZARDOUS (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
- D. Provide CORD AND PLUG SETS
- Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.3 SWITCHES

A. GENERAL

- Comply with NEMA WD 1 and UL 20.

- B. Provide 20 amp., toggle type, "Federal Specification Grade" lighting switches.

Single pole	GE #5951	Three-way	GE #5953
Double pole	GE #5952	Four-way	GE #5954

- C. Provide heavy duty, specification grade, 20 amp., quiet "AC", "DECORA" TOUCH SWITCHES. Catalog numbers are for Slater Medalist Decora Series.

Single pole	2770	Three-way	2773
Double pole	2772	Four-way	2774

- D. Provide Pilot Light Switches, 20 A, single pole, with neon-lighted handle, illuminated when switch is "ON."
- E. Provide Key-Operated Switches, 120/277 V, 20 A, Single pole, with factory-supplied key in lieu of switch handle.
- F. Provide Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
- G. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters, unless otherwise indicated on the drawings.
- Control: Continuously adjustable combination slider and toggle switch with single-pole or three-way switching to suit connections. Comply with UL 1472.

- H. Occupancy Sensors

1. As indicated on the drawings.
- I. Wall-Switch Sensors:
 1. As indicated on the drawings.
 - J. Emergency Lighting Relays
 1. Provide relays in emergency lighting circuits to cause emergency lights to automatically light whenever the emergency transfer switch goes to the emergency position, regardless of the position of the local switch.
 2. Provide SPDT transfer relays in NEMA #1 enclosure above accessible suspended ceiling or flush mounted adjacent to lighting panel. Provide one relay for each switch. Provide holding coils rated for continuous operation with 120 ampere contacts. Wire as indicated on the drawings or as directed
- 2.4 WALL PLATES
- A. Single and combination types to match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
 3. Material for Unfinished Spaces: Galvanized steel.
 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
 - B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, polycarbonate with lockable cover.
 - C. Single and combination types to match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Provide smooth (unribbed) high-impact thermoplastic switch and receptacle cover plates. Color as selected by Architect.
 3. Receptacles mounted outdoors or in other wet or damp locations shall be installed in weatherproof enclosures with key lock cover, the integrity of which is not affected when the receptacle is in use (attachment plug cap inserted).
- 2.5 MULTIOUTLET ASSEMBLIES
- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Wiremold Company (The).
 3. Panduit Corp.
 4. Equal approved by Engineer.
 - B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
 - C. Raceway Material: Metal, with manufacturer's standard finish.

2.6 SERVICE POLES

- A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices, connections, or outlets in pole near floor.
1. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 3. Finishes: Manufacturer's standard painted finish and trim combination.
 4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
 5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
 6. Voice and Data Communication Outlets: Provide type as indicated on the drawings or as directed.

2.7 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device 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 just 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 meet provisions of 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. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they 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 (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the 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.
10. Install devices and assemblies level, plumb, and square with building lines.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. 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. Remove wall plates and protect devices and assemblies during painting.

G. 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.
4. Install wall dimmers to achieve indicated rating after derating for ganging.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings. Obtain approval of adjustments from Architect/Engineer prior to installation.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and

durable wire markers or tags inside outlet boxes. Brother P-Touch Labeling System is acceptable, in lieu of engraving.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 3 percent or higher is not acceptable.
 - 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. The tests shall be diagnostic, indicating proper polarity, 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.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

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. Cartridge fuses rated 600-V AC and less for use in control circuits, enclosed switches, switchboards, enclosed controllers, and motor-control centers.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components. Include the following for each fuse type indicated:

- 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

- B. Operation and Maintenance Data: 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. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 4. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single source from a single manufacturer to the extent possible.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than 3 of each size and type.

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 the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.
 - 5. Gould
 - 6. Equal approved by Engineer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages, at class and current rating indicated.

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 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: Class L, time delay.
 - 2. Feeders: Class J, time delay.
 - 3. Motor Branch Circuits: Class RK5, time delay.
 - 4. Other Branch Circuits: Class RK1, time delay.
 - 5. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Molded-case switches.
 - 5. Electronic trip circuit breakers.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to Section 260548.
 - 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."

1.5 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.
- E. 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.
- F. Manufacturer's field service report.
- G. Operation and Maintenance Data: For enclosed switches and circuit breakers 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. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 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. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. 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.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application.
- E. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electric Service: Per Section 260500.

1.8 COORDINATION

- 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.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type GD, General Duty: not allowed.
- C. Type HD, Heavy Duty, Single Throw, 240 or 600-V AC, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V AC, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Double Throw, 240 or 600-V AC, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. Fusible switches, 800 amps and above: NEMA bolted pressure contact switches made by firmly bolting the switchblades to the stationary contact terminals and to the hinge terminals and meet UL 977.
- G. 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, capable of being grounded and bonded; 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. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
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.
9. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac or 120-V ac as required by the specific control system.

- H. All fusible switches: shall be rated for the application voltage specified and have a UL listed short circuit rating to match the fuse installed.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

- B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- C. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- D. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- E. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- F. 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, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

7. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac or 120-V ac as required by the specific control system.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 1. General Electric Company; GE Consumer & Industrial - Electrical Distribution – to match the base building standard.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current 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.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Where indicated or required, 100% rated, with RMS sensing, field-replaceable rating plug, trip indication (showing which adjustment caused trip), with interrupting capacity to meet available fault current, and with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
 5. Arc Energy Reduction via Energy-reducing maintenance switching with local status indicator for circuit breakers with 1200A frame or above.
 6. Settings shall be per the power system studies provided by the electrical contractor.
 7. Arc Flash Reduction:
 - a. Breakers where the highest continuous trip setting can be 1200 amps and above shall utilize Arc Flash Reduction Maintenance Technology. The unit shall have a dedicated operation mechanism and visual indication that the reduction technology is operating. The technology shall reduce the trip unit Instantaneous pickup value when activated. The device shall not comprise breaker phase protection when enabled. Once the unit is disabled, the recalibration of trip unit phase protection shall not be required. Activation and deactivation of the technology trip setting shall be accomplished without opening the circuit breaker door and exposing operators to energized parts.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

- J. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
- K. Switching Duty: All single pole circuit breakers shall be rated SWD.
- L. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits; Type HACR for heating, air-conditioning, and refrigerating equipment..
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - 7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 8. Alarm Switch: One NO or NC contact that operates only when switch has tripped. Coordinate with alarm system for exact configuration.
 - 9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 10. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - 11. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
 - 12. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.4 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
7. Alarm Switch: One NO or NC contact that operates only when switch has tripped. Coordinate with alarm system for exact configuration.
8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power Voltage: Remote mounted and powered; 24-V ac or 120-V ac as required by the specific control system.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncrosive Liquids: NEMA 250, Type 12.
 6. Indoor Hazardous Areas Indicated on Drawings, Class 1, Division 1: NEMA 250, Type 7.
 7. Indoor/Outdoor Hazardous Areas Indicated on Drawings, Class 1, Division 1: NEMA 250, Type 8.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with 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 individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and 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 fusible devices.
- F. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

- G. Most manufactures of bolted pressure switches make for line entering top and load exiting bottom. Verify shop drawings before running conduits.
- H. Do not mount switches or circuit breakers upside down or side ways.
- I. Aluminum Cable Connections: If aluminum wire is permitted, section "Conductors and Cables", circumferential compression type lugs are required for all terminations on aluminum wire. Where screw type lugs are used, it will be necessary to convert from aluminum to copper wiring before connection. This can be done by use of T & B or IlSCO, compression connectors. Adequate wiring space must be provided for connectors, if used.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "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. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Inspect mechanical and electrical connections.
 - 4. Verify switch and relay type and labeling verification.
 - 5. Verify rating of installed fuses.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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.
- C. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. 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 as specified in Division 26 Section "Power System Studies".
- C. Thermal-magnetic circuit breakers:
 - 1. Test circuit and correct deficiencies
 - 2. Set magnetic trip at minimum.
 - 3. Turn associated loads "on".
 - 4. Turn breaker on/off a minimum of six (6) times.

5. If nuisance tripping occurs, set "up" one notch and repeat test.
6. Repeat steps 4 and 5 until nuisance tripping no longer occurs.

D. Electronic trip-unit circuit breakers:

1. Test circuit and correct deficiencies.
2. Set "long time pickup" at 1.0 (Do not change)
3. Set other adjustments at minimum.
4. Turn associated loads "on".
5. Turn breaker on/off a minimum of six (6) times.
6. If nuisance tripping occurs, adjust setting that caused trip "up" one notch and repeat test.
7. Repeat steps 5 and 6 until nuisance tripping no longer occurs.

END OF SECTION 262816

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures with LED sources.
2. Lighting fixtures mounted on exterior building surfaces with LED sources.
3. Accessories, plaster rings, fasteners, etc.

1.2 RELATED DOCUMENTS:

- A. The General Conditions, Supplementary Conditions, and applicable portions of Division 1 of the specification are part of this section which shall consist of all labor, equipment, materials and other costs necessary to complete all INTERIOR LIGHTING work indicated on the drawings, herein specified or both.
- B. The applicable portions of section 260500 BASIC ELECTRICAL MATERIALS AND METHODS are hereby make a part of this section. It is important that you read that section carefully because it expands upon the requirements herein.

1.3 SUBMITTALS

- A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. Operation and maintenance data.

1.4 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 LIGHTING LUMINAIRES

- A. See schedules on drawings.
- B. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The

technical requirements that the luminaire shall meet for each Application Category as currently defined by the DLC Premium qualification requirements at the time of bid.

- C. Color Temperature of 3000K-3500K for interior luminaires as listed in the Luminaire Schedule on the plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).
- D. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 5-step MacAdam Ellipse binning process.
- E. Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- F. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- G. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
- H. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- I. Driver shall have a rated life of 50,000 hours, minimum.
- J. Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- K. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
- L. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
- M. LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
- N. LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
- O. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- P. Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
- Q. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
- R. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- S. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
- T. The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
- U. Provide all of the following data on submittals:

1. Delivered lumens
2. Input watts
3. Efficacy
4. Color rendering index.

- V. The failure of one LED shall not affect the operation of the remaining LEDs.
- W. Emergency Inverters shall be sine-wave type, or have written confirmation from the luminaire manufacturer that the luminaire will function with a square-wave inverter.
- X. LED driver shall be compatible with dimming controls where dimming is indicated on the plans. Dimmable drivers shall use Dimming Constant Current (DCC) or Pulse Width Modulation (PWM) operation.
- Y. LED luminaires shall dim to (20%, 15%, 10%, 5%, or 0.1%) as specified in the Luminaire Schedule on the plans without visible flicker or "popcorn effect". "Popcorn effect" is defined as the luminaire being on a pre-set dimmed level (less than 100%), and going to 100% prior to returning to the pre-set level when power is returned to the luminaire.

2.3 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture).
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage 2.68 mm.
- D. Wires For *Humid Spaces*: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
1. Install a minimum of four ceiling support system wires for each fixture. Locate not more than 6 inches (150 mm) from fixture corners.
 2. 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 (20-mm) metal channels spanning and secured to ceiling tees.
 3. Provide additional support, independent of ceiling grid for all fixtures (including incandescent) by use of jack chain having breaking strength of 3 times the weight of the fixture (minimum of #12). Fixtures over one foot in length shall be supported at all four corners.
 4. See section 260548, "Seismic Controls" for additional requirements.
- C. Suspended Fixture Support: As follows:
1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 3. Continuous Rows (cable mounted): Suspend from cable.

4. Support: Per NEC 410-16.
- D. Adjust aimable fixtures to provide required light intensities. Adjust all fixtures to the satisfaction of the Engineer. Adjustments required at night shall be done at no additional charge. Provide all equipment needed including scaffolding, if required.

END OF SECTION

SECTION 26 52 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Exterior luminaires and accessories
- B. Grounding
- C. Conduit and wiring

1.2 QUALITY ASSURANCE

- A. Comply with the following codes and standards:
 - 1. *National Electrical Code* (NEC) for components and installation.
 - 2. International Building Code
 - 3. ASCE-7, Minimum Design Loads for Buildings and Other Structures
 - 4. The national Energy Policy Act and Energy Star requirements for lighting products.
- B. Provide luminaires listed and labeled by a nationally recognized testing laboratory (NRTL) for the application, installation condition, and the environments in which installed.
- C. Use manufacturers that are experienced in manufacturing luminaires, lamps and ballasts similar to those indicated for this Project and have a record of successful in-service performance.

1.3 DEFINITIONS

- A. Unless otherwise specified or indicated, terms used in this Section are as defined in the National Electrical Code or the IESNA Lighting Handbook.

1.4 SUBMITTALS

- A. Submit the following in accordance with Project submittal procedures.
 - 1. **Catalog Data:** Submit catalog data describing luminaires, lamps, ballasts, and luminaire finishes. Include data substantiating that materials comply with specified requirements. Arrange data for luminaires in the order of luminaire designation.
 - 2. **Performance Curves/Data:** Submit certified photometric data for each type of luminaire.
 - 3. **Shop Drawings:** Submit manufacturer's drawings for non-standard luminaires.

4. Maintenance Data: Submit maintenance instructions for inclusion in the operations and maintenance manuals.

1.5 EXTRA MATERIALS

- A. Furnish the following extra materials matching products installed. Package with protective covering for storage and identify with labels describing contents.
 1. LED Luminaires: 10 percent of quantity of LED luminaires of each type, but no fewer than two of each type.
 2. Drivers: 10 percent of quantity of ballasts of each type, but not less than one of each type.
 3. Lenses, Diffusers, Covers, Globes, and Guards: 10 percent of quantity of each type, but not less than one of each type.

1.6 RECEIVING, STORING AND PROTECTING

- A. Receive, inspect, handle, and store products according to the manufacturer's written instructions and NECA/IESNA 501, *Recommended Practice for Installing Exterior Lighting Systems*.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Alternate products may be accepted; follow Section 01 2500 *Substitution Procedures*.

2.2 FINISHES

- A. Furnish luminaires and accessories with finishes as scheduled that are resistant to fading, chalking, and other changes due to aging and exposure to heat and ultraviolet light. Acceptable finishes for metals are:
 1. Hot-dipped galvanized steel: ASTM A 123/A 123M.
 2. Brushed natural aluminum
 3. Anodized aluminum: AAMA 611, *Anodized Architectural Aluminum, Class I*.
 4. Powder coated aluminum: Fluorocarbon polymer powder coating per AAMA 2605, *Superior Performing Organic Coatings* over chrome phosphate conversion coated aluminum.
- B. Reject luminaires and accessories with finish having runs, streaks, stains, holidays and defects.
- C. Replace luminaires and accessories showing evidence of yellowing, fading, chalking, and other changes indicating failure during warranty period.
- D. Use stainless steel for exposed hardware.

2.3 EXTERIOR LUMINAIRES - GENERAL

- A. Furnish exterior luminaires that comply with requirements specified in this Section and in the luminaire schedule on the Drawings.
- B. Luminaires shall be NRTL-listed as conforming to UL 1598 - *Luminaires*.
- C. Luminaire photometric characteristics shall be based on IESNA approved methods for photometric measurements performed by a recognized photometric laboratory.
- D. Luminaire housing shall be primarily metal.
 - 1. Metal parts shall be free from burrs and sharp corners and edges.
 - 2. Sheet metal components shall be fabricated from corrosion-resistant aluminum, formed and supported to prevent sagging and warping.
 - 3. Exposed fasteners shall be stainless steel.
- E. Doors and frames shall be smooth operating and free from light leakage under operating conditions.
 - 1. Relamping shall be possible without the use of special tools.
 - 2. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
 - 3. Door shall be removable for cleaning or replacing lens.
- F. Luminaires shall have minimum reflecting surface reflectance as follows unless scheduled otherwise:
 - 1. White surfaces: 85 percent
 - 2. Specular surfaces: 83 percent
 - 3. Diffusing specular surfaces: 75 percent
- G. Provide lenses, diffusers, covers and globes as scheduled on the Drawings fabricated from materials that are UV stabilized to be resistant to yellowing and other changes due to aging or exposure to heat and ultraviolet radiation.
- H. Doors shall have resilient gaskets that are heat-resistant and aging-resistant to seal and cushion lens and refractor.

2.4 LED LUMINAIRES

- A. LED luminaires shall conform to UL 1598 and to UL 8250 – *Safety Standard for Light-Emitting Diode (LED) Light Sources for Use in Lighting Products*.
- B. Products shall be lead and mercury free.
- C. Photometric characteristics shall be established using IESNA LM-79-08, *IESNA Approved Method for the Electrical and Photometric Measurement of Solid-State Lighting Products*.

- D. Ingress protection for optical assembly shall be IP65 or better in accordance with ANSI/IEC 60529 - *Degrees of Protection Provided by Enclosures*.
- E. Color characteristics of LED luminaires shall be as follows in accordance with ANSI C78.377 – *Specifications for the Chromaticity of Solid State Lighting Products*.
- F. LED and driver cooling system shall be passive and shall resist the buildup of debris.
- G. LED luminaire output after 50,000 hours of operation shall be not less than 70 percent of the initial lumen output when determined in accordance with IESNA LM-80-08 – *IESNA approved Method for Measuring Lumen Maintenance of LED Lighting Sources*.
- H. LED luminaire electrical characteristics:
 - 1. Supply voltage: 120 V, 208 V, 240 V, 277 V, or 480 V as indicated on the Drawings. Provide step-down transformers if required to match driver input voltage rating.
 - 2. Total harmonic distortion (current): Not more than 10 percent
 - 3. Power factor: Not less than 90%
 - 4. RF interference: Meet FCC 47 CFR Part 15/18
 - 5. Transient protection: IEEE C62.41 Class A.
- I. Warranty:
 - 1. Manufacturer shall replace any luminaires that fail to operate properly within 60 months of the date of acceptance of the installation. Lens yellowing or hazing will be considered a failure.
 - 2. Manufacturer shall replace any luminaires that experience housing or finish failure within 5 years of the date of acceptance of the installation.
- J. Manufacturers: Subject to compliance with requirements, provide products as scheduled or specified on the Drawings.

PART 3- EXECUTION

3.1 EXAMINATION

- A. Examine areas, spaces, and surfaces to receive exterior luminaire (s) for compliance with installation tolerances and other conditions affecting performance of the product. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions, NECA/IESNA 501, and approved shop drawings.
- B. Locations of luminaires shown on the Drawings are diagrammatic. Coordinate luminaire locations with building finishes, building structure, paving and striping, utility piping, security fences, and existing trees.
- C. Set luminaires plumb, square, level and secure.
- D. Install surface mounted luminaires directly to an outlet box which is supported from structure.

- E. Install lamps in luminaires in accordance with manufacturer's instructions.

3.3 CONCRETE FOUNDATIONS

- A. Construct concrete foundations with exterior 4000 psi concrete and reinforcing conforming to Section 03 3001, *Reinforced Concrete*.
- B. Comply with details on the Drawings and manufacturer's recommendations for foundation dimensions, reinforcing, anchor bolts, nuts and washers.

3.4 GROUNDING

- A. Install grounding for exterior lighting using materials and methods specified in Section 26 0526, *Grounding and Bonding for Electrical Systems*.

3.5 LIGHTING CONTROL SYSTEM

- A. Install exterior lighting control system components in accordance with the manufacturers' instructions. Have installation instructions available at the construction site.
- B. Provide separate control of exterior lighting system as follows:
 - 1. Pedestrian walkway, and roadway lighting: "ON" at dusk, "OFF" at dawn.

3.6 FUSES AND FUSE HOLDERS.

- A. Install fuse(s) and fuse holders in hand hole or transformer base for each luminaire.
 - 1. Install fuse holder and fuse in each phase conductor.
 - 2. Install fuse holder with permanently mounted dummy fuse in neutral conductor.
- B. Install insulator boots over fuse holders and tape wrap where conductor enters boot.

3.7 RACEWAYS AND BOXES

- A. Install conduit system for exterior lighting using materials and methods specified in Section 26 0533, *Raceways and Boxes for Electrical Systems*.

3.8 BUILDING WIRE

- A. Install wiring for exterior lighting using materials and methods specified in Section 26 0519, *Low Voltage Electrical Power Conductors and Cables*.

3.9 FIELD QUALITY CONTROL

- A. Inspect each installed lighting unit for damage. Replace damaged luminaires, and components.
- B. Test installed luminaires for proper operation.
 - 1. Provide instruments to make and record test results.

2. Replace or repair malfunctioning luminaires and components then re-test.
3. Repeat procedure until all luminaires operate properly.

C. Replace inoperative lamps.

3.10 ADJUSTING AND CLEANING

- A. Clean each luminaire inside and out, including plastics and glassware. Use methods and materials recommended by manufacturer.

END OF SECTION 26 52 00

SECTION 28 31 11 - ADDRESSABLE FIRE ALARM SYSTEM (EXTENSION OF EXISTING)

PART 1.0 - GENERAL

1.1 DESCRIPTION:

- A. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment to be connected to this buildings existing addressable fire alarm system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, auxiliary control devices, and wiring as shown on the drawings and specified herein.
- B. The fire alarm system extension shall comply with requirements of NFPA Standard No. 72 for Local Protected Premises Signaling Systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.
 - 1. All new fire alarm devices shall be compatible and of the same manufacturer as the existing EST, E3 series control panel.
- C. The FACP and peripheral devices shall be manufactured 100% by E.S.T.
- D. Underwriters Laboratories Inc. (UL) - USA:
 - UL 38 Manually Actuated Signaling Boxes
 - UL 268 Smoke Detectors for Fire Protective Signaling Systems
 - UL 521 Heat Detectors for Fire Protective Signaling Systems
 - UL 864 Standard for Control Units for Fire Protective Signaling Systems
 - UL 1481 Power Supplies for Fire Protective Signaling Systems
 - UL 1638 Visual Signaling Appliances
 - UL 2017 General-Purpose Signaling Devices and System
- E. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final check-out and to ensure the systems integrity.

1.2 SCOPE:

- A. Extension of existing EST E3 Fire Alarm system.
- B. Basic Performance:
 - 1. Initiation Device Circuits (IDC) shall be wired NFPA Style Z (Class A) as part of an addressable device connected by the SLC Circuit.
 - 2. When not wired directly from panel NAC circuits, Notification Appliance Circuits (NAC) shall be wired NFPA Style Z (Class A) as part of an addressable device connected by the SLC Circuit.
 - 3. All circuits shall be power-limited, per UL864 requirements.
 - 4. A single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

C. BASIC SYSTEM FUNCTIONAL OPERATION

When a fire alarm condition is detected and reported by one of the system initiating devices, the following elevator control functions shall immediately occur:

1. The elevator cabs shall travel to the first floor and the doors shall open.
2. If the first floor lobby smoke detector is in the alarm, the elevator cabs will travel to a pre-determine alternate floor and the doors shall open.
3. If the smoke detector in the elevator machine room or the heat detector located at the top of the shafts goes into alarm, the firemen hat shall illuminate notifying the fireman not to use the elevators.

1.3 SUBMITTALS

A. General:

1. An electronic copy of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment, if the minimum standards are met.
3. For equipment, other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

C. Software Modifications

1. Provide the services of a qualified technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
3. Provide firmware updates through USB thumb drive.

1.4 GUARANTY:

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period, shall be included in the submittal bid.

1.5 MAINTENANCE:

- A. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all

post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

1.6 APPLICABLE STANDARDS AND SPECIFICATIONS:

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

A. National Fire Protection Association (NFPA) - USA:

No. 13 Sprinkler Systems
No. 70 National Electric Code (NEC)
No. 72 National Fire Alarm Code
No. 101 Life Safety Code

B. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

C. Local and State Building Codes.

D. All requirements of the Authority Having Jurisdiction (AHJ).

1.8 APPROVALS:

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc (Ninth Edition)
FM Factory Mutual
CAN/ULC - S527-99 Standard for Control Units for Fire Alarm Systems

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a fire protective signaling system, meeting the National Fire Alarm Code.

B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

D. All equipment must be available "over the counter" through the Security Equipment Distributor (SED) market and can be installed by dealerships independent of the manufacturer.

2.2 CONDUIT AND WIRE:

A. Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
4. With the exception of telephone connections, wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch (19.1 mm) minimum.
7. Where fire alarm circuiting is run concealed above ceilings or fished in walls, U.L. listed fire alarm type "MC" cable can be use.
8. The supply and return loops shall be separated 5 feet horizontally and two feet vertically.

B. Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NEC 760 (e.g., FPLR).
5. Wiring used for the multiplex communication circuit (SLC) shall be twisted non-shielded and support a minimum wiring distance of 10,000 feet when sized at 12 AWG.
6. All field wiring shall be electrically supervised for open circuit and ground fault.

- C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

2.3 SYSTEM COMPONENTS:

A. Addressable Pull Box (manual station)

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual pull stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

B. Intelligent Multi-Sensing Detector

1. The intelligent detector shall be an addressable device which is capable of detecting multiple threats by employing photoelectric and thermal technologies in a single unit. This detector shall utilize advanced electronics which react to slow smoldering fires (photoelectric) and heat (thermal) all within a single sensing device.
2. The multi-detector shall include two LEDs for 360-degree viewing.
3. Automatically adjusts sensitivity levels without the need for operator intervention or programming. Sensitivity increases with heat.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
2. The detectors shall be ceiling-mounted and available in an alternate model with an integral fixed 135-degree heat-sensing element.
3. Each detector shall contain a remote LED output and a built-in test switch.
4. Detector shall be provided on a twist-lock base.
5. It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
6. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall periodically flash to indicate that the detector is in communication with the control panel.
7. The detector shall not go into alarm when exposed to air velocities of up to 1500 feet per minute (fpm).
8. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
9. All field wire connections shall be made to the base through the use of a clamping plate and screw.

D. Intelligent Thermal Detectors

1. Thermal detectors shall be intelligent addressable devices rated at 145 degrees Fahrenheit (58 degrees Celsius) and have a rate of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

E. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any normally open dry contact device) to one of the fire alarm control panel SLCs.
2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

F. Two-Wire Detector Monitoring

1. Means shall be provided for the monitoring of conventional Initiating Device Circuits

- populated with 2-wire smoke detectors as well as normally-open contact alarm initiating devices (pull stations, heat detectors, etc).
2. Each IDC of conventional devices will be monitored as a distinct address on the polling circuit by an addressable module. The module will supervise the IDC for alarms and circuit integrity (opens).
 3. The monitoring module will be compatible, and listed as such, with all devices on the supervised circuit.
 4. The IDC zone may be wired for Style D or Style B (Class A or B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
 5. The monitoring module shall be capable of mounting in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or in an surface mount backbox.

G. Addressable Control Relay Module

1. Addressable control relay modules shall be provided to control the operation of fan shutdown and other auxiliary control functions.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control relay module will provide a dry contact, Form-C relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relays may be energized at the same time on the same pair of wires.
4. The control relay module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

3.02 TEST:

The service of a competent, NICET level II technician shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 10.

- A. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- B. Open initiating device circuits and verify that the trouble signal actuates.
- C. Open and short signaling line circuits and verify that the trouble signal actuates.
- D. Open and short notification appliance circuits and verify that trouble signal actuates.
- E. Ground all circuits and verify response of trouble signals.
- F. Check presence and audibility of tone at all alarm notification devices.

- G. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- H. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3 FINAL INSPECTION:

- A. At the final inspection, a minimum NICET Level II technician shall demonstrate that the system functions properly in every respect.

3.4 INSTRUCTION:

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of elevator capture, alternate floor recall and firemen's cap functions shall be provided.

END OF SECTION 28 31 11

SECTION 311000 - SITE CLEARING

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. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and **[removing site utilities] [abandoning site utilities in place]**.
7. Temporary erosion- and sedimentation-control measures.

B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities[, **and temporary erosion- and sedimentation-control measures**].
2. Division 01 Section "Execution" for field engineering and surveying.
3. Division 01 Section(s) [**"Construction Waste Management and Disposal] [and] ["Sustainable Design Requirements"]**] for additional LEED requirements.
4. Division 02 Section "Structure Demolition" for demolition of buildings, structures, and site improvements.
5. Division 02 Section "Selective Structure Demolition" for partial demolition of buildings or structures.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically 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 and is 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 and is 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 more than **2 inches (50 mm)** in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and **[indicated on Drawings] [defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated] <Insert requirement>**.
- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises[**where indicated**] <Insert location>.
- D. Utility Locator Service: Notify [**utility locator service**] [**Miss Utility**] [**Call Before You Dig**] [**Dig Safe System**] [**One Call**] <Insert name> for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control[**and plant-protection**] measures are in place.
- F. The following practices are prohibited within protection zones:
 1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."
 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
- B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with [**MPI #79, Alkyd Anticorrosive Metal Primer**] [or] [**SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating**] <Insert manufacturer's name; product name or designation>.
 1. Use coating with a VOC content of [**420 g/L (3.5 lb/gal.)**] <Insert VOC limit> or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain[**or to be relocated**]. **[Flag] [Wrap a 1-inch (25-mm) blue vinyl tie tape flag around] <Insert requirement>** each tree trunk at **54 inches (1372 mm)** above the ground.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site according to requirements in Division 01 Section "Temporary Tree and Plant Protection."
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed[**or abandoned in place**].

1. Arrange with utility companies to shut off indicated utilities.
 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Architect not less than **[two]** **<Insert number>** days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Architect's written permission.
- E. Excavate for and remove underground utilities indicated to be removed.
- F. Removal of underground utilities is included in **[Division 21]** **[Division 22]** **[Division 23]** **[Division 26]** **[Division 27]** **[Division 28]** **[and]** **[Division 33]** Sections.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Grind down stumps and remove roots, obstructions, and debris to a depth of **[18 inches (450 mm)]** **<Insert dimension>** below exposed subgrade.
 3. Use only hand methods for grubbing within protection zones.
 4. Chip removed tree branches and **[stockpile in areas approved by Architect]** **[dispose of off-site]** **<Insert requirement>**.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding a loose depth of **8 inches (200 mm)**, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil **[to depth indicated on Drawings]** **[to depth of 6 inches (150 mm)]** **<Insert requirement>** in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than **2 inches (50 mm)** in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
1. Limit height of topsoil stockpiles to **72 inches (1800 mm)**.

2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

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 temporary excavation support and protection systems.
- B. Related Sections:
 - 1. Division 01 Section "[**Construction Progress Documentation**] [**Photographic Documentation**]" for recording preexisting conditions and excavation support and protection system progress.
 - 2. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
 - 3. Division 31 Section "Dewatering" for dewatering system for excavations.

1.3 PERFORMANCE REQUIREMENTS

- A. [**Design,**] furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
 - 1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 4. Monitor vibrations, settlements, and movements.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For excavation support and protection system.
- B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified [**land surveyor**] [**and**] [**professional engineer**].

B. Other Informational Submittals:

1. **[Photographs] [or] [Videotape]**: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.
2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.
 - a. Note locations and capping depth of wells and well points.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:
 - a. Geotechnical report.
 - b. Existing utilities and subsurface conditions.
 - c. Proposed excavations.
 - d. Proposed equipment.
 - e. Monitoring of excavation support and protection system.
 - f. Working area location and stability.
 - g. Coordination with waterproofing.
 - h. Abandonment or removal of excavation support and protection system.
 - i. **<Insert agenda items>**.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 1. Notify **[Architect] [Construction Manager] [Owner]** no fewer than **[two] <Insert number>** days 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.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.
 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 2. The geotechnical report is **[included] [referenced]** elsewhere in the Project Manual.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
 1. Corners: **[Site-fabricated mechanical interlock] [Roll-formed corner shape with continuous interlock]**.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of **[size and strength required for application] [3 inches (75 mm)] [4 inches (100 mm)] <Insert dimension>**.
- E. Shotcrete: Comply with Division 03 Section "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.
- F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- G. Reinforcing Bars: ASTM A 615/A 615M, **Grade 60 (Grade 420)**, deformed.
- H. Tiebacks: Steel bars, ASTM A 722/A 722M.
- I. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than **[2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment]** <Insert tolerances>.
- B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to **60 inches (1500 mm)**. Accurately align exposed faces of sheet piling to vary not more than **[2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment]** <Insert tolerances>. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

- A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
 - 1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
 - 2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
 - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 1. Remove excavation support and protection systems to a minimum depth of **48 inches (1200 mm)** below overlaying construction and abandon remainder.
 2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
 3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.
- B. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

SECTION 315000 – EARTHWORK FOR SMALL PROJECTS

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 DESCRIPTION OF WORK:

- A. Strip soil as herein specified or indicated.
- B. Stockpile surplus topsoil, if any, on site where directed.
- C. Excavation for foundations, rough grading, utility services and extensions. Excavation of all trades is included herein.
- D. Provide additional material hereinafter specified or needed for fills. Remove from site excess material and that which is unsuitable for filling, and legally dispose of it.
- E. Backfilling (including all trades).
- F. Compact fills as hereinafter specified.
- G. Repair any major deformations caused by the removal of large boulders, cave-ins, etc., with concrete, compacted bank run gravel or crushed stone.
- H. Protection and Precautionary Measurements:
 - 1. Carefully maintain bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed.
 - 2. Protect active pipes, if encountered, and notify persons owning same. If encountered, remove inactive utilities from within building lines. Plug or cap where indicated or directed.
 - 3. Protect persons and property from damage and discomfort caused by dust. Water as necessary to quell dust.
- I. Erosion Control:
 - 1. Employ satisfactory methods and operations to minimize erosion of soil during earthwork operations. Follow accepted standards of the R.I.D.O.T. for erosion control.

1.3 RELATED WORK UNDER OTHER SECTIONS:

- A. Spreading and/or providing new topsoil - Section 329200 Landscaping.

1.4 ELEVATION AND OBSTRUCTIONS:

- A. The Contract is based upon the following: that the surface elevations, utilities and physical features are as indicated and the contractor shall be responsible to verify its accuracy both underground and overhead. There will be no extra payment for additional work required due to conflicts with the survey information either shown or not shown.
- B. Ground water levels indicated are those existing at the time subsurface investigations were made and do not necessarily represent permanent ground water levels. It is the Contractor's responsibility to determine reasonable variations in ground water levels which may affect the work. There will be no extra payment for any class of rock excavation.

1.5 QUALITY ASSURANCE:

- A. Materials, methods and compaction tests will be subject to approval of an approved inspection agency specified in Section 014000.
- B. Code and Standards: Perform excavation work in compliance with applicable requirement of governing authorities having jurisdiction.

1.6 REQUIREMENTS:

- A. One gradation curve and moisture-density curve for each type of material specified or proposed for use for approval. (AASHTO T-27 and AASHTO T-180)
- B. A minimum of two in-place density tests for each lift of material placed or two for each 200 cubic yards of material placed, whichever results in the greatest number of tests. (AASHTO T-191, T-205 or T-310 In-Place Density Testing by Nuclear Methods)
 - 1. Topsoil Analysis - documenting pH and organic content of on-site material and material to be hauled in.
 - 2. Material delivered to the project shall be tested for compliance with the approved gradation, one test shall be made for each 750 cubic yards of material delivered.
- C. Prior to production and delivery to the site the Contractor shall, together with a representative of the Testing Laboratory chosen by the Owner, obtain at the source two representative 50 lb. samples of all materials proposed for use. Samples shall be placed in lined containers so as to prevent any loss of material during transportation. One sample will be analyzed by the Testing Laboratory for conformance with this specification, should the material be rejected a second at the source sampling shall be made. Upon approval of a material, the second sample taken at the source and not used for analysis shall be delivered by the Testing Laboratory to the Owner's representative at the site for his use. Each sample taken shall be clearly marked as follows:
 - 1. Project Name
 - 2. Architect's Name
 - 3. Contractor's Name
 - 4. Supplier's Name and Source
 - 5. Date Sample Taken
 - 6. Name of Sampler
 - 7. Intended Use and Specification Reference

- D. Test results shall be approved before delivery of any material to the site. Any change in source of materials or quality will require a new series of tests at no additional expense to the Owner.
- E. All unsatisfactory work and any settlement within one (1) year of final acceptance shall be removed, replaced and retested at the Contractor's expense.

1.7 MISCELLANEOUS REQUIREMENTS:

- A. Traffic: Conduct operations and the removal of debris to ensure minimum interference with roads, streets, walks and other adjacent occupied or used facilities.
 - 1. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
 - 2. Provide all traffic control required and pay all costs incurred.
- B. Damages: Promptly repair damages caused to adjacent facilities by operations, as directed and at no additional cost.

PART 2 - PRODUCTS

NOT APPLICABLE.

PART 3 - EXECUTION

3.1 EXCAVATIONS:

- A. Topsoil Removal:
 - 1. Before starting to excavate, strip available topsoil, subsoil and unsuitable material from areas to be covered by improvements and where cuts or fills are required.
 - 2. Topsoil is defined as friable clay from surface soil found in a depth of not less than 4". Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2" in diameter, and without weeds, roots, and other objectionable material.
 - a. pH - 5.5 to 7.6 Organic content - 5% minimum, 20% maximum.
 - 3. Verify depth of topsoil within contract limits. If additional topsoil is needed to fulfill topsoil spread requirements, contractor shall provide topsoil from off-site sources as part of this contract, at his expense.
 - 4. Strip topsoil to whatever depths encountered, unless shown otherwise, and in such manner so as to prevent intermingling with the underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.
 - 5. Remove unsuitable materials and legally dispose of off site.
 - 6. Stockpile topsoil in storage piles in areas shown, or where otherwise indicated. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent windblown dust. Topsoil remains property of Owner.

B. General Open Earth Excavation:

1. Excavate as necessary for work shown or specified. Remove earth, rocks, boulders, and other obstructions as herein defined.
2. Allow ample space for form work.
3. Leave bearing surfaces undisturbed, level and true. Excavate to solid bearing at elevations no higher than those shown.

C. General Trench Earth Excavation:

1. Excavate trenches for pipe lines along straight lines.
2. Keep trench width at top of pipe to the minimum needed for proper workmanship in installing pipe and making joints.
3. Excavate the bottom of the trenches in earth and rock to the dimensions and depths indicated, below the bottom of all pipes, to provide for gravel bedding beneath the pipes.
4. Whenever wet or otherwise unsuitable soil (that which is incapable of properly supporting pipe as determined by the Architect) is encountered in the bottom of the trench, remove such soil to the depth required. Following the removal of such material, backfill the trench and satisfactorily compact to the proper grade with approved granular backfill.
5. Form under bell ends to allow for jointing and to give the pipe a uniform bearing along the barrel only.

D. Excavation of Existing Pavement:

1. Remove all areas of existing pavement as indicated and as required for the construction of the work under the contract. Where excavation of existing roadway or sidewalk pavement is required, saw cut the existing pavement and remove, to the extent required by the local authorities, leaving straight vertical edges. Any existing pavements beyond these lines so established, which is damaged, or destroyed by the Contractor shall be replaced after the backfill has been placed and approved, restore the pavements to match existing pavements or as required by the local authorities and in an approved manner. All work to comply with local codes and ordinances having jurisdiction.

E. Rock Excavation:

1. Remove all rock to the levels indicated below, or as directed.
2. There will be no extra payment for all classifications of rock removal.
3. Rock is defined as boulders; stone or hard shale in original ledge; concrete footings, foundations, etc.; and other obstructions, in excess of one cubic yard, which cannot be broken and removed from site by normal job equipment (power shovels, 1-1/2 cubic yard capacity scoops, or bulldozers).
4. Level off or shelve rock surfaces to a slope not exceeding one (1) vertical to twelve (12) horizontal, or as directed; before placing masonry or concrete on it.

F. Extent of Rock Removal:

1. For structures or portions thereof: one foot outside the base of walls or footings.

2. For floor slabs or existing building slab removal: six (6) inches below the bottom of slabs on grade.
3. Walks, Plaza, and paved areas: eight (8) inches below the subgrade lines.
4. For pipe trenches: twelve (12) inches outside bell of pipe up to 24" in diameter; and eighteen (18) inches outside bell of pipe over 24" in diameter in a vertical plane and twelve (12) inches below the outside of the pipe barrel.
5. Lawn and shrub areas: eighteen (18) inches below finish grade.

G. Dewatering and Pumping:

1. Provide, construct, and maintain, at no additional expense to the Owner, all pumps, piping, drains, well points, or any other facility for the control and collection of ground water or surface water. Provide dewatering operations of such a nature so that all excavations are kept, at all times, free from water, so that all construction is performed in a dry working area, including soil for a minimum distance of 1'-0" below foundations and footings. Repair any damage resulting from the failure of the dewatering operations and any damage resulting from the failure to maintain the area of all structure and work in a suitably dry condition as directed by the Architect, and at no additional expense to the Owner. Perform the pumping and dewatering operations in such a manner, that no loss of ground/soils will result from these operations. Take necessary precautions to protect new and existing work from flooding during storms and from other causes. Provide continuous pumping where required to protect the work and/or to maintain satisfactory progress. All pipelines or structures not stable against uplift during construction or prior to completion shall be thoroughly braced or otherwise protected. Water shall not be conducted onto adjacent property.

H. Unauthorized Excavation:

1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect.
 - a. Under footings, foundation bases or retaining walls, fill unauthorized excavation by extending the indicated bottom elevation of the footing or base to the excavation bottom without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, only when acceptable.
 - b. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed.
 - c. Do all corrective work as specified above at no expense to the Owner.

I. Stability of Excavations:

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible either because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

J. Shoring and Bracing:

1. Brace and shore sides of excavation as necessary to prevent danger to persons or damage to structures, injurious caving or erosion.
2. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and crossbraces, in good serviceable condition.
3. Provide shoring and bracing to comply with local codes and authorities having jurisdiction.
4. Maintain shoring and bracing in excavation regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.
 - a. Repair slides and cave-ins should they occur.
 - b. Remove shoring and bracing before backfilling.
 - c. In removing shoring and bracing, exercise care to prevent voids. Immediately fill voids, if formed, with approved fill material.

K. Water and Frost:

1. Keep earth under footings and slabs dry and free from frost.
2. Should bearing surfaces be softened by water or frost, re-excavate to solid bearing and fill with concrete or gravel as directed at no expense to Owner.

3.2 FILLING:

A. General:

1. Remove debris and organic matter before filling.
2. Use approved materials only for fills.
3. Obtain Architect's approval before filling.
4. Make fills as soon as feasible thereafter to insure maximum settlement.
5. Do not place fill on frozen ground.
6. Provide all material free from frost, roots and other vegetable matter, large rocks, rubbish, brick and other undesirable material.
7. Install fills in indicated thicknesses.
8. Provide neat, uniform side slopes (smooth and graded) to those excavations not required to be filled.

B. Fill Materials: Unless specifically shown otherwise, use the following materials:

1. "Graded Gravel Fill" (under slab on grade at building, Plaza and sidewalks; although a similar graded bank-run gravel may be acceptable) free from loam, recycled materials, and other specified undesirable materials, conforming to the following analysis:

Sieve Size	% Passing by Weight
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3"	100
1-1/2"	75-95
3/4"	60-85
3/8"	45-75
#4	30-65
#40	6-25
#200	0-4

- a. On-site material may be used under Plaza and sidewalks areas only after satisfactory test data has been submitted, and only with the Architect's approval.
2. "Bank Run Gravel" in pipe trenches, around manholes and catch basins, against dampproofed foundation walls, where indicated as "gravel fill", and where else shown, free from loam, recycled materials, and other specified undesirable material, and conforming to the following analysis:

Sieve Size	% Passing by Weight
3"	100
1/2"	50-85
3/8"	45-80
#4	40-75
#40	15-35
#200	0-8

- a. On-site material may be used, only after satisfactory test data has been submitted, and only with the Architect's approval.
3. "Stone" (to stabilize utilities and foundations as necessary and where indicated) conforming to the following analysis:

Sieve Size	% Passing by Weight
2-1/4"	100
2"	90-100
1-1/2"	30-55
1-1/4"	0-25
1"	0-5
#200	0

4. "Filter Stone" (around french drains and combination drains, at retaining walls and where else indicated) shall be washed and free from clay, silt, organic matter, or other objectionable material and conforming to the following analysis:

Sieve Size	% Passing by Weight
1"	100
3/4"	70-85
1/2"	10-40
3/8"	0-20
#4	0-5
#200	0

5. "Sand" (if indicated) consisting of clean, inert, hard, durable grains of quartz or other hard durable rock; free from loam or clay, surface coatings and deleterious material; and conforming to the following analysis:

Sieve Size	% Passing by Weight
#8	100
#50	25-40
#100	0-10

#200 0-5

6. Fill Material for Trenches:
 - a. Bedding for pipe - "Bank Run Gravel", except with 100% passing 3/4" sieve (stone if unsuitable material is encountered).
 - b. Over pipe - Two 6" layers of "Bank Run Gravel", except with 100% passing 3/4" sieve.
 - c. Remaining Fill - "Bank Run Gravel"; approved on-site or new material, free from stones over 4" diameter and other specified undesirable materials.
7. Fill Material for Other Areas:
 - a. Any of the aforementioned.
 - b. Excess on-site material, as approved.

3.3 COMPACTION:

A. General:

1. Prior to the placement of any fill or backfill, the natural ground under the building area and areas to be paved shall be compacted using an approved vibratory compactor. Where area is sufficient for proof rolled with vehicle, provide at least two passes of a fully loaded ten wheel dump truck or equivalent to verify firm ground, in areas inaccessible to proof rolling, an approved vibratory compactor shall be used.
2. Place fill in horizontal layers, beginning with the lowest areas and building up until the entire area to be filled is at a uniform elevation.
3. Compact each layer with an approved vibratory device to achieve minimum density requirements.
4. Continue compaction of each layer until there is no evidence of weaving or creeping. Compact places inaccessible to large equipment with approved mechanical tampers as well as around the perimeter of foundations, walls and around column pedestals and footings.
5. Do not use rolling equipment in the area adjacent to the foundation and retaining walls.
6. Earth in cut sections for roadway and parking lot areas shall be excavated to subgrade. The resulting surface of the cut shall be compacted as required, to not less than 95% of maximum density.
7. Earth in embankment section for roadway and parking lot areas, below a plane of one foot below subgrade shall be compacted to not less than 95% of maximum density in 12 inch loose layers.
8. Remainder of the roadway section up to subgrade shall be compacted to 95% of maximum density in two 6 inch layers.
9. For compaction within building areas and/or beneath structures with foundations, see "Controlled Compacted Fill".

10. Elsewhere, compact to 95% of maximum density in 12 inch loose layers, except for two 6 inch layers directly over pipes.
11. Attention is directed to the grain size characteristics of the material and necessity for and difficulty of controlling and maintaining optimum moisture content during compaction. Material in each layer shall contain optimum moisture for maximum density compaction and the optimum moisture content shall be uniformly distributed throughout the layer. Harrowing or other working of the material may be required to produce uniformity and control of the water content.
12. Slope the surface of each layer 1%, plus or minus .25% at the conclusion of each day's work to provide surface drainage.
13. Maximum density for compacted soils shall be determined by ASTM D 1557, Method C.
14. Whenever in-place densities are below minimum acceptable limits, as determined by AASHTO T-191, T-205 or T-310 In-Place Density Testing by Nuclear Methods, additional compaction will be required to produce the specified densities, without additional cost to the Owner. When greater densities than the minimum specified are required by the Architect, the work will be subject to contract unit prices.

3.4 CONTROLLED COMPACTED FILL:

- A. All fills within the building area and/or beneath foundations shall be constructed prior to construction of foundations and shall be constructed under laboratory control to result in 98% of maximum density at optimum moisture below footing elevations and 95% of maximum density from elevation of bottom of footing to underside of slab. The extent of this fill is within 3 feet of foundations, proceeding out at a 45 degree angle, or as indicated on the site plan and in the typical earthwork section, or as directed.
- B. Retain a laboratory and Geotechnical Engineer approved by the Architect, to supervise and control the construction of the fill. This laboratory shall perform tests in accordance with ASTM D 1557 on the materials the Contractor proposed to use to establish the compacted dry weight at optimum moisture. Results of these tests shall be submitted to the Architect for approval and work may start only after the Architect approves the test results. The Architect, or approved testing laboratory under the direction of the Architect, shall provide continuous inspection of compacted fills.
- C. Backfilling material shall conform to laboratory requirements herein specified and shall be soil obtained from an approved borrow pit.
- D. The area to be filled shall be cleared of all loose material and inspected and approved by the Geotechnical Engineer.
 1. Fill material shall be free from frost and shall not be placed on frozen ground. Fill shall be deposited in layers of such thickness as required by its nature or as directed, but the uncompacted thickness of each layer shall not exceed 8".
 2. Each layer shall be separately compacted to a uniform solid mass by use of vibratory compactors or other approved equipment. Fill shall be placed in horizontal layers, beginning with the lowest areas and building up until the entire area to be filled is at a uniform elevation.

3. The Contractor shall control the moisture content of the fill material, as directed by the laboratory to insure maximum density by either the addition of water, or by harrowing and working prior to compacting.
4. Each layer shall be free of ruts and shall meet compaction requirements before a succeeding layer is placed. Compaction of each layer shall continue until no weaving or creeping takes place.
- E. Backfill in areas excavated after construction of the fill shall be constructed in layers whose loose thickness shall not exceed 6" and shall be thoroughly compacted with approved hand equipment to the density hereinbefore specified.
- F. Field tests of moisture content prior to compaction and dry weight after compaction shall be made by the laboratory to insure thorough and uniform compaction. Testing shall be performed on the layer just compacted.
- G. At least two tests of moisture content shall be made each day. Additional tests shall be made if material or moisture conditions change.

3.5 ROUGH GRADING:

A. General:

1. Grade entire area of work area on property to reasonably true and even surfaces, thoroughly compacted to indicated elevations.
2. Slope ground away from existing and/or new building walls to facilitate drainage.
3. Grade to uniform levels or slopes between points where grades are noted or as necessary to facilitate proper drain per building codes.
4. Round surfaces at abrupt changes in levels.
5. Should figures conflict with contours, consult Architect.

B. Levels:

1. Grade paving, walks and other surfaces areas to subgrade.
2. Grade lawn areas to 6" below finish grades.
3. Ground cover areas to 9" below finish grade.
4. Shrub beds to 3" below finish grade.

C. Grading Around Trees:

1. Raising Grade: (not more than 16 inches)
2. Place washed gravel directly around trunk before any earth fill is placed near tree.
3. Extend gravel not less than 18 inches around all sides of tree, top approximately 2 inches above finished grade at tree.

D. Lowering Grades:

1. Do regrading by hand to levels and extent indicated.
2. Cut roots as required 3 inches inside bank, and paint ends with tree wound paint.

3.6 USE OF EXPLOSIVES:

- A. The use of explosives will not be permitted.

- B. Mechanical means shall be employed for rock removal.
- C. Non explosives agents such as Bustar (formally called Bristar) may be used when approved by Owner and Architect prior.

END OF SECTION 31 50 05

SECTION 321313 - CONCRETE PAVING

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. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

B. Related Sections:

1. Division 03 Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]" for general building applications of concrete.
2. Division 32 Section "Decorative Concrete Paving" for stamped concrete other than detectable warnings. Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]" for general building applications of concrete.
3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Indicate 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 product, ingredient, or admixture requiring color selection.
- D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
 1. **Exposed Aggregate:** [10-lb (4.5-kg)] <Insert weight> Sample of each mix.

- 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. Qualification Data: For qualified [Installer of detectable warnings] and [ready-mix concrete manufacturer]
- B. 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.
- C. 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.]
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. 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 that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- E. ACI Publications: Comply with **ACI 301 (ACI 301M)** unless otherwise indicated.
- F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

CONCRETE PAVING

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. **Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than [96 inches (2400 mm) by 96 inches.**
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. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at 600 Mount Pleasant Street Providence, RI.

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.
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 detectable warnings.

1.7 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of **[40 deg F (4.4 deg C) for oil-based materials] [55 deg F (12.8 deg C) for water-based materials]**, and not exceeding **95 deg F (35 deg C)**.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 1. **Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. [Do not use notched and bent forms.]**
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] <Insert number> percent.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from [as-drawn] [galvanized]-steel wire into flat sheets.
- C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- D. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
- E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
- F. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
- G. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
- H. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.
- I. Plain-Steel Wire: ASTM A 82/A 82M, [as drawn] [galvanized].
- J. Deformed-Steel Wire: ASTM A 496/A 496M.
- K. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, [plain] [deformed].
- L. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating]. Cut bars true to length with ends square and free of burrs.
- M. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.
- N. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- O. Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- P. 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.
- Q. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

- R. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
1. **Portland Cement:** ASTM C 150, [gray] [white] portland cement [Type I] [Type II] [Type I/II] [Type III] [Type V]. [Supplement with the following:]
 - a. Fly Ash: ASTM C 618, [Class C] [or] [Class F].
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 2. **Blended Hydraulic Cement:** ASTM C 595, [Type IS, portland blast-furnace slag] [Type IP, portland-pozzolan] cement.
- B. Normal-Weight Aggregates: ASTM C 33, [Class 4S] [Class 4M] [Class 1N] <Insert class>, 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: [1-1/2 inches (38 mm)] [1 inch (25 mm)] [3/4 inch (19 mm)] nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
1. **Aggregate Sizes:** [3/4 to 1 inch (19 to 25 mm)] [1/2 to 3/4 inch (13 to 19 mm)] [3/8 to 5/8 inch (10 to 16 mm)] <Insert dimensions> nominal.
 2. **Aggregate Source, Shape, and Color:** <Insert requirements>.
- D. Water: Potable and complying with ASTM C 94/C 94M.
- E. Air-Entraining Admixture: ASTM C 260.
- F. 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 C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- G. 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. **Manufacturers:** Subject to compliance with requirements, [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. ChemMasters.
 - b. Davis Colors.

- c. Dayton Superior Corporation.
 - d. Elementis Pigments.
 - e. Hoover Color Corporation.
 - f. Lambert Corporation.
 - g. LANXESS Corporation.
 - h. QC Construction Products.
 - i. Scofield, L. M. Company.
 - j. Solomon Colors, Inc.
 - k. Stampcrete International, Ltd.
 - l. SureCrete Design Products.
 - m. <Insert manufacturer's name>.
2. **Color:** [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.

2.4 FIBER REINFORCEMENT

- A. Synthetic Fiber: [Monofilament] [or] [fibrillated] polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, [**1/2 to 1-1/2 inches (13 to 38 mm)**] <Insert dimensions> long.
1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
- a. Monofilament Fibers:
 - 1) Axim Italcementi Group, Inc.; FIBRASOL II P.
 - 2) Euclid Chemical Company (The), an RPM company; Fiberstrand 100, Fiberstrand 150.
 - 3) FORTA Corporation; [**FORTA ECONO-MONO**] [or] [**FORTA Mighty-Mono**].
 - 4) Grace, W. R. & Co. - Conn.; Grace MicroFiber.
 - 5) Metalcrete Industries; Polystrand 1000.
 - 6) QC Construction Products; QC FIBERS.
 - 7) <Insert manufacturer's name; product name or designation>.
 - b. Fibrillated Fibers:
 - 1) Axim Italcementi Group, Inc.; FIBRASOL F.
 - 2) Euclid Chemical Company (The), an RPM company; Fiberstrand F.
 - 3) FORTA Corporation; [**FORTA Econo-Net**] [or] [**FORTA Super-Net**].
 - 4) Grace, W. R. & Co. - Conn.; Grace Fibers.
 - 5) Propex Concrete Systems Corp.; Fibermesh 300.
 - 6) <Insert manufacturer's name; product name or designation>.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, [**Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry**] [or] [cotton mats].
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Axim Italcementi Group, Inc.; Caltexol CIMFILM.
 - b. BASF Construction Chemicals, LLC; Confilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec by Dayton Superior; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film (J-74).
 - f. Edoco by Dayton Superior; BurkeFilm.
 - g. Euclid Chemical Company (The), an RPM company; Eucobar.
 - h. Kaufman Products, Inc.; VaporAid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-CON.
 - k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; MONOFILM.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
 - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; PRO-FILM.
 - s. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.
 - t. <Insert manufacturer's name; product name or designation>.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Anti-Hydro International, Inc.; A-H Curing Compound #2 DR WB.
 - b. ChemMasters; Safe-Cure Clear.
 - c. Conspec by Dayton Superior; [D.O.T. Resin Cure] [DSSCC Clear Resin Cure].
 - d. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
 - e. Edoco by Dayton Superior; [DSSCC Clear Resin Cure] [Resin Emulsion Cure V.O.C. (Type I)].
 - f. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; AQUA KURE - CLEAR.
 - i. L&M Construction Chemicals, Inc.; L&M CURE R.
 - j. Meadows, W. R., Inc.; 1100-CLEAR SERIES.
 - k. Nox-Crete Products Group; Resin Cure E.
 - l. SpecChem, LLC; PaveCure Rez.
 - m. Symons by Dayton Superior; Resi-Chem Clear.
 - n. Tamms Industries, Inc., Euclid Chemical Company (The); TAMMSCURE WB 30C.
 - o. TK Products, Division of Sierra Corporation; [TK-2519 WB] [TK-2519 DC WB].
 - p. Vexcon Chemicals Inc.; Certi-Vex EnvioCure 100.
 - q. <Insert manufacturer's name; product name or designation>.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Anti-Hydro International, Inc.; A-H Curing Compound #2 WP WB.
 - b. ChemMasters; Safe-Cure 2000.
 - c. Conspec by Dayton Superior; **[D.O.T. Resin Cure White] [DSSCC White Resin Cure]**.
 - d. Dayton Superior Corporation; Day-Chem White Pigmented Cure (J-10-W).
 - e. Edoco by Dayton Superior; Resin Emulsion Cure V.O.C. (Type II).
 - f. Euclid Chemical Company (The), an RPM company; Kurez VOX White Pigmented.
 - g. Kaufman Products, Inc.; Thinfilm 450.
 - h. Lambert Corporation; AQUA KURE - WHITE.
 - i. L&M Construction Chemicals, Inc.; L&M CURE R-2.
 - j. Meadows, W. R., Inc.; 1100-WHITE SERIES.
 - k. SpecChem, LLC; PaveCure Rez White.
 - l. Symons by Dayton Superior; Resi-Chem White.
 - m. Vexcon Chemicals Inc.; Certi-Vex Enviocure White 100.
 - n. **<Insert manufacturer's name; product name or designation>**.

2.6 RELATED MATERIALS

- A. Joint Fillers: **[ASTM D 1751, asphalt-saturated cellulosic fiber] [or] [ASTM D 1752, cork or self-expanding cork]** 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 C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. 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, of grade complying with requirements, and of the following types:
 1. **[Types I and II, non-load bearing] [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 (3 to 6 mm)**.
 1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. ChemMasters; Exposee.
 - b. Conspec by Dayton Superior; Delay S.
 - c. Dayton Superior Corporation; Sure Etch (J-73).
 - d. Edoco by Dayton Superior; True Etch Surface Retarder.
 - e. Euclid Chemical Company (The), an RPM company; Surface Retarder Formula S.
 - f. Kaufman Products, Inc.; Expose.
 - g. Meadows, W. R., Inc.; TOP-STOP.
 - h. Metalcrete Industries; Surfard.

- i. Nox-Crete Products Group; CRETE-NOX TA.
 - j. Scofield, L. M. Company; LITHOTEX Top Surface Retarder.
 - k. Sika Corporation, Inc.; Rugasol-S.
 - l. SpecChem, LLC; Spec Etch.
 - m. TK Products, Division of Sierra Corporation; TK-6000 Concrete Surface Retarder.
 - n. Unitex; TOP-ETCH Surface Retarder.
 - o. Vexcon Chemicals Inc.; Certi-Vex Envioset.
 - p. <Insert manufacturer's name; product name or designation>.
- F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
1. **Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Anti-Hydro International, Inc.; A-H S-Q Hardener.
 - b. BASF Construction Chemicals, LLC; Mastercron.
 - c. ChemMasters; ConColor.
 - d. Conspec by Dayton Superior; Conshake 600 Colortone.
 - e. Dayton Superior Corporation; Quartz Tuff.
 - f. Euclid Chemical Company (The), an RPM company; Surfex.
 - g. Lambert Corporation; COLORHARD.
 - h. L&M Construction Chemicals, Inc.; QUARTZPLATE FF.
 - i. Metalcrete Industries; Floor Quartz.
 - j. Scofield, L. M. Company; LITHOCHROME Color Hardener.
 - k. Southern Color N.A., Inc.; Mosaics Color Hardener.
 - l. Stampcrete International, Ltd.; Color Hardener.
 - m. Symons by Dayton Superior; Hard Top.
 - n. <Insert manufacturer's name; product name or designation>.
 2. **Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color>.**
- G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch (9.5-mm) sieve and 85 percent retained on a No. 8 (2.36-mm) sieve.

2.7 DETECTABLE WARNING MATERIALS

- A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
1. **Manufacturers: Subject to compliance with requirements, [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. Advanced Surfaces Inc.
 - b. Matcrete Precision Stamped Concrete Tools.
 - c. Southern Color N.A., Inc.
 - d. Stampcrete International Ltd.
 - e. Superior Decorative by Dayton Superior.
 - f. <Insert manufacturer's name>.
 2. **Size of Stamp: One piece [matching detectable warning area shown on Drawings] [24 by 24 inches (610 by 610 mm)] [24 by 36 inches (610 by 914 mm)] [24 by 48 inches**

(610 by 1220 mm)] [26 by 26 inches (660 by 660 mm)] [26 by 36 inches (660 by 914 mm)] <Insert dimensions>.

- B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.
1. **Products:** Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Advanced Surfaces Inc.; Liquid Release.
 - b. Matcrete Precision Stamped Concrete Tools; Liquid Release Agent.
 - c. Southern Color N.A., Inc.; SCC Clear Liquid Release.
 - d. Stampcrete International Ltd.; Stampcrete Liquid Release.
 - e. Superior Decorative by Dayton Superior; Pro Liquid Release.
 - f. <Insert manufacturer's name; product name or designation>.

2.8 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), 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 meet or exceed requirements.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
1. **Compressive Strength (28 Days):** [4500 psi (31 MPa)] [4000 psi (27.6 MPa)] [3500 psi (24.1 MPa)] [3000 psi (20.7 MPa)] <Insert strength>.
 2. **Maximum Water-Cementitious Materials Ratio at Point of Placement:** [0.45] [0.50] <Insert ratio>.
 3. **Slump Limit:** [4 inches (100 mm)] [5 inches (125 mm)] [8 inches (200 mm)] <Insert dimension>, plus or minus 1 inch (25 mm).
- 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:** [5-1/2] [4-1/2] [2-1/2] percent plus or minus 1.5 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.
 2. **Air Content:** [6] [4-1/2] [3] percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.
 3. **Air Content:** [6] [5] [3-1/2] percent plus or minus 1.5 percent for 3/4-inch (19-mm) nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to [0.15] [0.30] 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. Cementitious Materials: [**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.**][**Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:**]
1. Fly Ash or Pozzolan: 25 percent.
 2. Ground Granulated Blast-Furnace Slag: 50 percent.
 3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- G. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than [1.0 lb/cu. yd. (0.60 kg/cu. m)] [1.5 lb/cu. yd. (0.90 kg/cu. m)] <Insert requirement>.
- H. 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.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M [**and ASTM C 1116/C 1116M**]. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between **85 and 90 deg F (30 and 32 deg C)**, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above **90 deg F (32 deg C)**, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For concrete batches of **1 cu. yd. (0.76 cu. m)** or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 2. For concrete batches larger than **1 cu. yd. (0.76 cu. m)**, increase mixing time by 15 seconds for each additional **1 cu. yd. (0.76 cu. m)**.
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

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] <Insert locations> 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 (5 km/h).**
 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than **15 tons (13.6 tonnes)**.

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3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of [1/2 inch (13 mm)] <Insert dimension> according to requirements in Division 31 Section "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 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. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- F. 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 D 3963/D 3963M.
- G. 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 (50-mm)** 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 (38 mm)** 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 (15.25 m)] <Insert dimension> unless otherwise indicated.**
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than **1/2 inch (13 mm)** or more than **1 inch (25 mm)** 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 (6-mm)] [3/8-inch (10-mm)] 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 (75 mm)] <Insert dimension>** either way from centers of dowels.
 2. Sawn Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch- (3-mm-)** 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 (75 mm)] <Insert dimension>** 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 (6-mm)** [**3/8-inch (10-mm)**] 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 (ACI 301M)** 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 (ACI 301M)** 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 bleed water 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.
- L. Cold-Weather 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 (4.4 deg C)**, uniformly heat water and aggregates before mixing to obtain a concrete mixture

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temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) 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.

M. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) 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.**

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 bleed-water 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 (1.6 to 3 mm) 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 (1.6 mm)**.
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. (12 kg/10 sq. m)] [40 lb/100 sq. ft. (19.5 kg/10 sq. m)] [60 lb/100 sq. ft. (29 kg/10 sq. m)] <Insert rate of application> of dampened, slip-resistive 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-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive 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-resistive 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.
- D. Rock-Salt Finish: After initial **[floating] [troweling] [brooming]**, uniformly spread rock salt over paving surface at the rate of **5 lb/100 sq. ft. (0.2 kg/10 sq. m)**.
1. **Embed rock salt into plastic concrete with [roller] [or] [magnesium float] <Insert tool>.**
 2. Cover paving surface with **1-mil- (0.025-mm-)** thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
 3. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.
- E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:
1. **Uniformly spread dry-shake hardener at a rate of [100 lb/100 sq. ft. (49 kg/10 sq. m)] <Insert rate of application>, unless greater amount is recommended by manufacturer to match paving color required.**
 2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
 3. After final power floating, apply a hand-trowel finish followed by a broom finish.
 4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

3.9 DETECTABLE WARNINGS

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in **[Division 32 Section "Unit Paving"] <Insert Division number and Section title>**.
1. **Tolerance for Opening Size: [Plus 1/4 inch (6 mm), no minus] <Insert requirement>**.
- B. 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] <Insert number> 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 (1 kg/sq. m 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] [or] [a combination of these]** 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 (300-mm)** 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 (300 mm)** and sealed by waterproof tape or adhesive. Immediately repair any holes or

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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 that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.11 PREFORMED TRAFFIC-CALMING DEVICES

- A. Install preformed speed **[bumps]** **[humps]** **[cushions]** in bed of adhesive applied as recommended by manufacturer for heavy traffic.
- B. Securely attach preformed speed **[bumps]** **[humps]** **[cushions]** to paving with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 1. Testing Frequency: Obtain at least one composite sample for each **[100 cu. yd. (76 cu. m)]** **[5000 sq. ft. (465 sq. m)]** 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 shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; 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 C 231, 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 C 1064/C 1064M; one test hourly when air temperature is **40 deg F (4.4 deg C)** and below and when it is **80 deg F (27 deg C)** and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall 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 (3.4 MPa)**.

- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall 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 shall 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 REPAIRS 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 321373 - CONCRETE PAVING JOINT SEALANTS

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. Cold-applied joint sealants.
2. Cold-applied, jet-fuel-resistant joint sealants.
3. Hot-applied joint sealants.
4. Hot-applied, jet-fuel-resistant joint sealants.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.
2. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
3. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 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]** **[manufacturer's standard test method]** 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 no fewer than **[eight]** **<Insert number>** pieces of each type 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 compatibility with and adhesion to joint substrates and other materials matching those submitted.

CONCRETE PAVING JOINT SEALANTS

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Pavement-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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified [**Installer**] [**testing agency**].
- B. Product Certificates: For each type of joint sealant and accessory, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.
- D. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.6 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 type 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.
- D. Preinstallation Conference: Conduct conference at [**Project site**] <Insert location>.

1.7 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

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1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below 40 deg F (5 deg C)**].
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.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backing materials, 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. Colors of Exposed Joint Sealants: **[As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range] <Insert color>**.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Crafcro Inc., an ERGON company; RoadSaver Silicone.
 - b. Dow Corning Corporation; 888.
 - c. Pecora Corporation; 301 NS.
 - d. **<Insert manufacturer's name; product name or designation>**.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Crafcro Inc., an ERGON company; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Pecora Corporation; 300 SL.
 - d. **<Insert manufacturer's name; product name or designation>**.
- C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.

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1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Pecora Corporation; Urexpan NR-200.
 - b. **<Insert manufacturer's name; product name or designation>**.

2.3 COLD-APPLIED, JET-FUEL-RESISTANT JOINT SEALANTS

- A. Jet-Fuel-Resistant, Single-Component, Pourable, Traffic-Grade, Modified-Urethane Joint Sealant for Concrete: ASTM C 920, Type S, Grade P, Class 25, for Use T.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. BASF Building Systems; Sonomeric 1.
 - b. **<Insert manufacturer's name; product name or designation>**.
- B. Jet-Fuel-Resistant, Multicomponent, Pourable, Traffic-Grade, Modified-Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 12-1/2, for Use T.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Pecora Corporation; Urexpan NR-300.
 - b. **<Insert manufacturer's name; product name or designation>**.
- C. Jet-Fuel-Resistant, Multicomponent, Pourable, Traffic-Grade, Modified-Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Meadows, W. R., Inc.; Sealtight Gardox.
 - b. **<Insert manufacturer's name; product name or designation>**.

2.4 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.
 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Crafco Inc., an ERGON company; Superseal 444/777.
 - b. **<Insert manufacturer's name; product name or designation>**.

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- B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Meadows, W. R., Inc.; **[Sealtight Hi-Spec] [Sealtight 3405]**.
 - b. Right Pointe; D-3405 Hot Applied Sealant.
 - c. **<Insert manufacturer's name; product name or designation>**.

2.5 HOT-APPLIED, JET-FUEL-RESISTANT JOINT SEALANTS

- A. Hot-Applied, Jet-Fuel-Resistant, Single-Component Joint Sealant for Concrete: ASTM D 7116, Type I.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Crafcro Inc., an ERGON company; Superseal 444/777.
 - b. **<Insert manufacturer's name; product name or designation>**.
- B. Hot-Applied, Jet-Fuel-Resistant, Single-Component Joint Sealant for Concrete and Tar Concrete: Single-component formulation complying with ASTM D 3581.
1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Crafcro Inc., an ERGON company; Superseal 1614A.
 - b. **<Insert manufacturer's name; product name or designation>**.

2.6 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

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2.7 PRIMERS

- A. Primers: Product 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.

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.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on 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.

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. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install joint-sealant backings of kind indicated to support joint 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 joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place joint sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.

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3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements 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 joint sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess joint 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.

3.5 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 and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within cement concrete pavement[<PJS-#>].
 1. Joint Location:
 - a. Expansion and isolation joints in cast-in-place concrete pavement.
 - b. Contraction joints in cast-in-place concrete slabs.
 - c. <Insert joints>.
 - d. Other joints as indicated.
 2. Silicone Joint Sealant for Concrete: [**Single component, nonsag**] [**Single component, self-leveling**] <Insert joint sealant>.
 3. Urethane Joint Sealant for Concrete: [**Multicomponent, pourable, traffic-grade**] <Insert joint sealant>.
 4. Hot-Applied Joint Sealant for Concrete: [**Single component**] <Insert joint sealant>.
 5. Joint-Sealant Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.

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- B. Joint-Sealant Application: Fuel-resistant joints within cement concrete pavement[<PJS-#>].
1. Joint Location:
 - a. Expansion and isolation joints in cast-in-place concrete pavement.
 - b. Contraction joints in cast-in-place concrete slabs.
 - c. <Insert joints>.
 - d. Other joints as indicated.
 2. Jet-Fuel-Resistant, Modified-Urethane Joint Sealant for Concrete: [**Single-component, pourable, traffic-grade**] [**Multicomponent, pourable, traffic-grade, Class 12-1/2**] [**Multicomponent, pourable, traffic-grade, Class 25**] <Insert joint sealant>.
 3. Hot-Applied, Jet-Fuel-Resistant, Joint Sealant for Concrete: [**Single component**] <Insert joint sealant>.
 4. Joint-Sealant Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.
- C. Joint-Sealant Application: Joints between cement concrete and asphalt pavement[<PJS-#>].
1. Joint Location:
 - a. Joints between concrete and asphalt pavement.
 - b. Joints between concrete curbs and asphalt pavement.
 - c. <Insert joints>.
 - d. Other joints as indicated.
 2. Hot-Applied Joint Sealant for Concrete and Asphalt: [**Single component**] <Insert joint sealant>.
 3. Joint-Sealant Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.
- D. Joint-Sealant Application: Fuel-resistant joints between cement concrete and tar-concrete pavement[<PJS-#>].
1. Joint Location:
 - a. Joints between concrete and tar-concrete pavement.
 - b. Joints between concrete curbs and tar-concrete pavement.
 - c. <Insert joints>.
 - d. Other joints as indicated.
 2. Hot-Applied, Jet-Fuel-Resistance Joint Sealant for Concrete and Tar Concrete: [**Single component**] <Insert joint sealant>.
 3. Joint-Sealant Color: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color>.

END OF SECTION 321373

CONCRETE PAVING JOINT SEALANTS.

SECTION 329200 - TURF AND GRASSES

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. Seeding.
2. Hydroseeding.
3. Sodding.
4. Plugging.
5. Sprigging.
6. Meadow grasses and wildflowers.
7. Turf renovation.
8. Erosion-control material(s).
9. Grass paving.

B. Related Sections:

1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
3. Division 32 Section "Porous Unit Paving" for concrete grid-type pavers shaped to provide open areas between units, planted with grass or other plants.
4. Division 32 Section "Planting Irrigation " for turf irrigation.
5. Division 32 Section "Plants" for border edgings.
6. Division 33 Section "Subdrainage" for subsurface drainage.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.5 INFORMATIONAL SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for **[turfgrass sod] [plugs]**. Include identification of source and name and telephone number of supplier.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For **[soil amendments] [and] [fertilizers]**, from manufacturer.
- D. Material Test Reports: For **[standardized ASTM D 5268 topsoil] [existing native surface topsoil] [existing in-place surface soil] [and] [imported or manufactured topsoil]**.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf **[and meadows]** during a calendar year. Submit before expiration of required initial maintenance periods.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf **[and meadow]** establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Experience: **[Three] [Five] <Insert number>** years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. Personnel Certifications: Installer's **[field supervisor] [personnel assigned to the Work]** shall have certification in **[one of] [all of]** the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with **[installation] [maintenance] [irrigation]** specialty area(s), designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
 5. Maintenance Proximity: Not more than **[two] <Insert number>** hours' normal travel time from Installer's place of business to Project site.
 6. Pesticide Applicator: State licensed, commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; **[sodium absorption ratio;]**deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of **[three] <Insert number>** representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per **1000 sq. ft. (92.9 sq. m)** or volume per **cu. yd. (0.76 cu. m)** for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D. Preinstallation Conference: Conduct conference at **[Project site] <Insert location>**.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- C. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers[, **lime**,] and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
1. Spring Planting: **<Insert dates>**.
 2. Fall Planting: **<Insert dates>**.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.9 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
1. Seeded Turf: **[60]** **<Insert number>** days from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
 2. Sodded Turf: **[30]** **<Insert number>** days from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
 3. Plugged Turf: **[30]** **<Insert number>** days from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
 4. Sprigged Turf: **[30]** **<Insert number>** days from date of **[planting completion]** **[Substantial Completion]** **<Insert starting time>**.
- B. Initial Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than **[40]**

<Insert number> days from date of [planting completion] [Substantial Completion] <Insert starting time>.

- C. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species: State-certified seed of grass species as follows:
- C. Seed Species: Seed of grass species as follows, with not less than [95] <Insert number> percent germination, not less than [85] <Insert number> percent pure seed, and not more than [0.5] <Insert number> percent weed seed:
1. Full Sun: Bermudagrass (*Cynodon dactylon*).
 2. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 3. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 4. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).
- D. Grass Seed Mix: Proprietary seed mix as follows:
1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. <Insert manufacturer's name; product name or designation>.

2.2 TURFGRASS SOD

- A. Turfgrass Sod: [Certified] [Approved] [Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects], complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

- B. Turfgrass Species: **[Bermudagrass (Cynodon dactylon)] [Carpetgrass (Axonopus affinis)] [Centipedegrass (Eremochloa ophiuroides)] [St. Augustinegrass (Stenotaphrum secundatum)] [Zoysiagrass (Zoysia japonica)] [Zoysiagrass (Zoysia matrella)] <Insert species>**.
- C. Turfgrass Species: Sod of grass species as follows, with not less than **[95]** <Insert number> percent germination, not less than **[85]** <Insert number> percent pure seed, and not more than **[0.5]** <Insert number> percent weed seed:
1. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 2. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 3. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

2.3 PLUGS

- A. Plugs: Turfgrass sod, **[certified] [approved] [Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects]**, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, cut into square or round plugs, strongly rooted, and capable of vigorous growth and development when planted; of the following turfgrass species and plug size:
1. Turfgrass Species: **[Bermudagrass (Cynodon dactylon)] [Carpetgrass (Axonopus affinis)] [Centipedegrass (Eremochloa ophiuroides)] [St. Augustinegrass (Stenotaphrum secundatum)] [Zoysiagrass (Zoysia japonica)] [Zoysiagrass (Zoysia matrella)] <Insert species>**.
 2. Plug Size: **[2 inches (50 mm)] [3 inches (75 mm)] [4 inches (100 mm)] <Insert size>**.

2.4 SPRIGS

- A. Sod Sprigs: Healthy living stems, rhizomes, or stolons with a minimum of two nodes and attached roots free of soil, of the following turfgrass species:
1. Turfgrass Species: **[Bermudagrass (Cynodon dactylon)] [Carpetgrass (Axonopus affinis)] [Centipedegrass (Eremochloa ophiuroides)] [St. Augustinegrass (Stenotaphrum secundatum)] [Zoysiagrass (Zoysia japonica)] [Zoysiagrass (Zoysia matrella)] <Insert species>**.
 2. Turfgrass Species: Creeping bentgrass (*Agrostis palustris*).

2.5 MEADOW GRASSES AND WILDFLOWERS

- A. Wildflower Seed: Fresh, clean, and dry new seed, of mixed species as follows:
 - 1. **<Insert mix of wildflower species>**.
- B. Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as follows:
 - 1. **<Insert mix of native grass species>**.
- C. Wildflower and Native Grass Seed: Fresh, clean, and dry new seed, of mixed species as follows:
 - 1. **<Insert mix of wildflower and native grass species>**.
- D. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.6 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: T, with a minimum of 99 percent passing through **No. 8 (2.36-mm)** sieve and a minimum of 75 percent passing through **No. 60 (0.25-mm)** sieve.
 - 2. Class: O, with a minimum of 95 percent passing through **No. 8 (2.36-mm)** sieve and a minimum of 55 percent passing through **No. 60 (0.25-mm)** sieve.
 - 3. Provide lime in form of ground **[dolomitic limestone] [calcitic limestone] [mollusk shells] <Insert material>**.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through **No. 6 (3.35-mm)** sieve and a maximum of 10 percent passing through **No. 40 (0.425-mm)** sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through **No. 50 (0.30-mm)** sieve.
- G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
- H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.7 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through [1-inch (25-mm)] [3/4-inch (19-mm)] [1/2-inch (12.5-mm)] sieve; soluble salt content of [5 to 10] <Insert range or value> decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: [50 to 60] <Insert range> percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of [0.15 lb/cu. ft. (2.4 kg/cu. m)] <Insert rate> of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of [0.25 lb/cu. ft. (4 kg/cu. m)] <Insert rate> of loose sawdust or ground bark.
- E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.8 FERTILIZERS

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of [1] [4] percent nitrogen and [10] [20] percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.9 PLANTING SOILS

- A. Planting Soil **<Insert drawing designation>**: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of [2] [4] [6] **<Insert number>** percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth. Mix ASTM D 5268 topsoil with the following soil amendments[**and fertilizers**] in the following quantities to produce planting soil:
1. Ratio of Loose Compost to Topsoil by Volume: [1:4] [1:3] [1:2] **<Insert ratio>**.
 2. Ratio of Loose [Sphagnum] [Muck] Peat to Topsoil by Volume: **<Insert ratio>**.
 3. Ratio of Loose Wood Derivatives to Topsoil by Volume: **<Insert ratio>**.
 4. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 5. Weight of [Sulfur] [Iron Sulfate] [Aluminum Sulfate] per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 6. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 7. Volume of Sand Plus 10 Percent [Diatomaceous Earth] [Zeolites] per 1000 Sq. Ft. (92.9 Sq. m): **<Insert volume>**.
 8. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 9. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 10. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 11. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
- B. Planting Soil **<Insert drawing designation>**: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process[**and stockpiled on-site**]. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
1. Supplement with [another specified] **<Insert drawing designation>** planting soil when quantities are insufficient.
 2. Mix existing, native surface topsoil with the following soil amendments[**and fertilizers**] in the following quantities to produce planting soil:
 - a. Ratio of Loose Compost to Topsoil by Volume: [1:4] [1:3] [1:2] **<Insert ratio>**.
 - b. Ratio of Loose [Sphagnum] [Muck] Peat to Topsoil by Volume: **<Insert ratio>**.
 - c. Ratio of Loose Wood Derivatives to Topsoil by Volume: **<Insert ratio>**.
 - d. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 - e. Weight of [Sulfur] [Iron Sulfate] [Aluminum Sulfate] per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 - f. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 - g. Volume of Sand Plus 10 Percent [Diatomaceous Earth] [Zeolites] per 1000 Sq. Ft. (92.9 Sq. m): **<Insert volume>**.
 - h. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 - i. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 - j. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
 - k. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): **<Insert weight>**.
- C. Planting Soil **<Insert drawing designation>**: Existing, in-place surface soil. Verify suitability of existing surface soil to produce viable planting soil. Remove stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix surface soil with

the following soil amendments[**and fertilizers**] in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Surface Soil by Volume: [1:4] [1:3] [1:2] <Insert ratio>.
 2. Ratio of Loose [Sphagnum] [Muck] Peat to Surface Soil by Volume: <Insert ratio>.
 3. Ratio of Loose Wood Derivatives to Surface Soil by Volume: <Insert ratio>.
 4. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 5. Weight of [Sulfur] [Iron Sulfate] [Aluminum Sulfate] per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 6. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 7. Volume of Sand Plus 10 Percent [Diatomaceous Earth] [Zeolites] per 1000 Sq. Ft. (92.9 Sq. m): <Insert volume>.
 8. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 9. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 10. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 11. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
- D. Planting Soil <Insert drawing designation>: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from [agricultural land,]bogs or marshes.
1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch (25 mm) or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.
 2. Mix imported topsoil or manufactured topsoil with the following soil amendments[**and fertilizers**] in the following quantities to produce planting soil:
 - a. Ratio of Loose Compost to Topsoil by Volume: [1:4] [1:3] [1:2] <Insert ratio>.
 - b. Ratio of Loose [Sphagnum] [Muck] Peat to Topsoil by Volume: <Insert ratio>.
 - c. Ratio of Loose Wood Derivatives to Topsoil by Volume: <Insert ratio>.
 - d. Weight of Lime per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - e. Weight of [Sulfur] [Iron Sulfate] [Aluminum Sulfate] per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - f. Weight of Agricultural Gypsum per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - g. Volume of Sand Plus 10 Percent [Diatomaceous Earth] [Zeolites] per 1000 Sq. Ft. (92.9 Sq. m): <Insert volume>.
 - h. Weight of Bonemeal per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - i. Weight of Superphosphate per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - j. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
 - k. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): <Insert weight>.
- E. Lightweight On-Structure Planting Soil <Insert drawing designation>: Mix produced by modifying planting soil as follows:

1. Planting Soil <Insert drawing designation>: [One] <Insert number> part(s), except replace [all] [half] <Insert amount> of sand content with perlite.
2. Additional Perlite: [One] <Insert number> part(s).
3. Additional [Sphagnum] [Muck] Peat: [One] <Insert number> part(s).
4. Additional Lime: Ground [dolomitic limestone] [calcitic limestone] [mollusk shells] <Insert material> applied at the rate of [3 lb per cu. yd. (1.36 kg per cu. m)] <Insert rate>.
5. <Insert material and quantity>.

2.10 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.
- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of [2 to 5] <Insert range or value> decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 1. Organic Matter Content: [50 to 60] <Insert range> percent of dry weight.
 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.11 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.12 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, **6 inches (150 mm)** long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of **0.92 lb/sq. yd. (0.5 kg/sq. m)**, with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, **6 inches (150 mm)** long.
- C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of **[3-inch (75-mm)] [4-inch (100-mm)] [6-inch (150-mm)]** <Insert dimension> nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.
 - 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Invisible Structures, Inc.; Slopetame 2.
 - b. Presto Products Company, a business of Alcoa; Geoweb.
 - c. Tenax Corporation - USA; Tenweb.
 - d. <Insert manufacturer's name; product name or designation>.

2.13 GRASS-PAVING MATERIALS

- A. Grass Paving: Cellular, non-biodegradable plastic mats, designed to contain small areas of soil and enhance the ability of turf to support vehicular and pedestrian traffic, of **[1-inch (25-mm)] [1-3/4-inch (45-mm)] [2-inch (50-mm)] [manufacturer's standard]** <Insert dimension> nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.
 - 1. Products: Subject to compliance with requirements, **[provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]**:
 - a. Grid Technologies, Inc.; Netlon 50.
 - b. Invisible Structures, Inc.; Grasspave2.
 - c. NDS, Inc.; **[Tufftrack] [Grassroad Paver8 Plus]**.
 - d. Presto Products Company, a business of Alcoa; Geoblock Porous Pavement System.
 - e. RK Manufacturing, Inc.; Grassy Pavers.
 - f. <Insert manufacturer's name; product name or designation>.
- B. Base Course: Sound crushed stone or gravel complying with **[ASTM D 448 for Size No. 8] [Division 31 Section "Earth Moving" for base-course material]** <Insert requirements>.
- C. Sand: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
- D. Proprietary Growing Mix: As submitted and acceptable to Architect.

- E. Sandy Loam Soil Mix: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate blended with planting soil <Insert drawing designation> as specified. Use blend consisting of [1/2 sand and 1/2 planting soil] [2/3 sand and 1/3 planting soil] <Insert proportions>.
- F. Soil for Paving Fill: Planting soil <Insert drawing designation> as specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of [4 inches (100 mm)] [6 inches (150 mm)] [8 inches (200 mm)] <Insert depth>. Remove stones larger than [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] <Insert size> in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply [superphosphate] <Insert type> fertilizer directly to subgrade before loosening.
 2. [Thoroughly blend planting soil off-site before spreading] [or] [spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil].
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 3. Spread planting soil to a depth of [4 inches (100 mm)] [6 inches (150 mm)] [8 inches (200 mm)] <Insert depth> but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top [2 inches (50 mm)] [4 inches (100 mm)] of subgrade. Spread remainder of planting soil.
 - b. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 2. Loosen surface soil to a depth of at least [6 inches (150 mm)] [8 inches (200 mm)]. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top [4 inches (100 mm)] [6 inches (150 mm)] of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Apply [superphosphate] <Insert type> fertilizer directly to surface soil before loosening.
 3. Remove stones larger than [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (50 mm)] in any dimension and sticks, roots, trash, and other extraneous matter.
 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- 3.4 PREPARATION FOR EROSION-CONTROL MATERIALS
- A. Prepare area as specified in "Turf Area Preparation" Article.
 - B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 PREPARATION FOR GRASS-PAVING MATERIALS

- A. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus **1/2 inch (13 mm)** of finish elevation. Roll and rake, remove ridges, and fill depressions.
- B. Install **[base course] [and] [sand course]** and **[sandy loam soil mix] [proprietary growing mix] [soil for paving fill]** as recommended by paving-material manufacturer for site conditions; comply with details shown on Drawings. Compact according to paving-material manufacturer's written instructions.
- C. Install paving mat and fasten according to paving-material manufacturer's written instructions.
- D. Before planting, fill cells of paving mat with **[planting soil] [sandy loam soil mix] [proprietary growing mix] [sand half full]** and compact according to manufacturer's written instructions.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.6 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds **5 mph (8 km/h)**. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of **[2 lb/1000 sq. ft. (0.9 kg/92.9 sq. m)] [3 to 4 lb/1000 sq. ft. (1.4 to 1.8 kg/92.9 sq. m)] [5 to 8 lb/1000 sq. ft. (2.3 to 3.6 kg/92.9 sq. m)] <Insert rate>**.
- C. Rake seed lightly into top **1/8 inch (3 mm)** of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding **[1:4 with erosion-control blankets] [and] [1:6 with erosion-control fiber mesh]** installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of [2 tons/acre (42 kg/92.9 sq. m)] <Insert rate> to form a continuous blanket [1-1/2 inches (38 mm)] <Insert thickness> in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 2. Bond straw mulch by spraying with asphalt emulsion at a rate of [10 to 13 gal./1000 sq. ft. (38 to 49 L/92.9 sq. m)] <Insert rate>. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying [compost mulch] [peat mulch] [planting soil] within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of [3/16 inch (4.8 mm)] <Insert thickness>, and roll surface smooth.

3.7 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
1. Mix slurry with [nonasphaltic] [asphalt-emulsion] [fiber-mulch manufacturer's recommended] tackifier.
 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than [1500-lb/acre (15.6-kg/92.9 sq. m)] <Insert rate> dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
 3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than [500-lb/acre (5.2-kg/92.9 sq. m)] <Insert rate> dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of [1000 lb/acre (10.4 kg/92.9 sq. m)] <Insert rate>.

3.8 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
1. Lay sod across angle of slopes exceeding 1:3.
 2. Anchor sod on slopes exceeding 1:6 with wood pegs [or steel staples] spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of **1-1/2 inches (38 mm)** below sod.

3.9 PLUGGING

- A. Plant plugs in holes or furrows, spaced [**12 inches (300 mm)**] [**18 inches (450 mm)**] <Insert spacing> apart in both directions. On slopes, contour furrows to near level.

3.10 SPRIGGING

- A. Plant freshly shredded sod sprigs in furrows [**1 to 1-1/2 inches (25 to 38 mm)**] [**1-1/2 to 2 inches (38 to 50 mm)**] [**2-1/2 to 3 inches (64 to 75 mm)**] deep. Place individual sprigs with roots and portions of stem in moistened soil, [**6 inches (150 mm)**] [**12 inches (300 mm)**] <Insert spacing> apart in rows [**10 inches (250 mm)**] [**18 inches (450 mm)**] <Insert spacing> apart, and fill furrows without covering growing tips. Lightly roll and firm soil around sprigs after planting.
- B. Broadcast sprigs uniformly over prepared surface at a rate of [**10 cu. ft./1000 sq. ft. (0.28 cu. m/92.9 sq. m)**] <Insert rate> and mechanically force sprigs into lightly moistened soil.
 - 1. Spread a **1/4-inch- (6-mm-)** thick layer of [**compost mulch**] [**peat mulch**] [**planting soil**] on sprigs.
 - 2. Lightly roll and firm soil around sprigs after planting.
 - 3. Water sprigs immediately after planting and keep moist by frequent watering until well rooted.

3.11 TURF RENOVATION

- A. Renovate existing turf.
- B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 - 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
 - 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of **6 inches (150 mm)**.
- I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top **4 inches (100 mm)** of existing soil. Install new planting soil to fill low spots and meet finish grades.
- J. Apply [**seed and protect with straw mulch**] [**sod**] as required for new turf.
- K. Water newly planted areas and keep moist until new turf is established.

3.12 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of **4 inches (100 mm)**.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of **1 inch (25 mm)** per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow [**bentgrass**] <Insert grass species> to a height of **1/2 inch (13 mm)** or less.
 - 2. Mow [**bermudagrass**] <Insert grass species> to a height of **1/2 to 1 inch (13 to 25 mm)**.
 - 3. Mow [**carpetgrass**] [**centipedegrass**] [**perennial ryegrass**] [**zoysiagrass**] <Insert grass species> to a height of **1 to 2 inches (25 to 50 mm)**.
 - 4. Mow [**Kentucky bluegrass**] [**buffalograss**] [**annual ryegrass**] [**chewings red fescue**] <Insert grass species> to a height of **1-1/2 to 2 inches (38 to 50 mm)**.
 - 5. Mow [**bahiagrass**] [**turf-type tall fescue**] [**St. Augustinegrass**] <Insert grass species> to a height o **2 to 3 inches (50 to 75 mm)**.
- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that will provide actual nitrogen of at least [**1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m)**] <Insert rate> to turf area.

3.13 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding **[90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm)]** <Insert coverage>.
 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
 3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
 4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.14 MEADOW

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds **5 mph (8 km/h)**. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow seed at a total rate of **[4 oz./1000 sq. ft. (113 g/92.9 sq. m)] [5 oz./1000 sq. ft. (142 g/92.9 sq. m)] [6 oz./1000 sq. ft. (170 g/92.9 sq. m)]** <Insert rate>.
- C. Brush seed into top **1/16 inch (1.6 mm)** of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas from hot, dry weather or drying winds by applying **[peat] [or] [compost]** mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of **3/16 inch (4.8 mm)**, and roll surface smooth.
- E. Water newly planted areas and keep moist until meadow is established.

3.15 MEADOW MAINTENANCE

- A. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep meadow uniformly moist.
 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water meadow with fine spray at a minimum rate of **1/2 inch (13 mm)** per week for **[four] [six] [eight]** weeks after planting unless rainfall precipitation is adequate.

3.16 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.17 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200