

ADDENDUM NO. 1

April 1, 2024

KPS LOY NORRIX HIGH SCHOOL HEALTH SUITE
606 East Kilgore Road
Kalamazoo, MI 49001

TO: ALL BIDDERS OF RECORD

This Addendum forms a part of and modifies the Bidding Requirements, Contract Forms, Contract Conditions, the Specifications and the Drawings dated March 8, 2024, by TowerPinkster. Acknowledge receipt of the Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

This Addendum consists of Pages ADD 1-1 and TowerPinkster Addendum No. 1, dated March 29, 2024, consisting of 2 pages and entire new Project Manual, Volume No. 2.

A. SPECIFICATION SECTION 00 00 20 – TABLE OF CONTENTS

1. Replace entire Specification Section 00 00 20 – Table Of Contents.

B. SPECIFICATION SECTION 00 43 00 – SUBCONTRACTORS AND PRODUCTS LIST

1. Replace entire Subcontractors and Products List 00 43 00 – Subcontractors and Products List.

C. SPECIFICATION SECTION 01 12 00 – MULTIPLE CONTRACT SUMMARY

1. Replace entire Multiple Contract Summary 01 12 00b – Multiple Contract Summary.

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SECTION 00 43 50 - SUBCONTRACTORS AND PRODUCTS LIST

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The two (2) low responsive Bidders in each Bid Category shall furnish electronically, the following Subcontractors and Products List to the Construction Manager within **two (2) working days (48 hrs.) of bid opening, unless submitted with Bid.** The blanks appropriate to the Bid Category(ies) on which they bid shall be completed.
 - 1. The Owner and Architect shall have the right to select any material or equipment named in the Specifications for any particular item where the Bidder either fails to list same or lists more than one name for the item in question.
 - 2. It is intended that this list will show the manufacturer and supplier of major items of work that will be subcontracted and to whom.

1.02 INSTRUCTIONS FOR SUBCONTRACTORS AND PRODUCTS LISTS

- A. Each Bidder shall submit a copy of his list of subcontractors and manufacturers of products and equipment proposed for work indicated as required above.
- B. The list shall be submitted on forms provided and shall be completely executed. **"As Specified" or "With Equipment" type of terminology will not be accepted.**
- C. Under "Subcontractor", insert the name of the firm which the Bidder proposes to have perform the respective work. If work will be done by the Prime Bidder and no subcontract will be awarded, state "By Own Forces".
- D. Submission does not constitute acceptance for use of listed manufacturers' products. Materials and subcontractors are subject to the provisions of the General Conditions and "Standard of Product Acceptability" and must be formally reviewed and adjudged acceptable by the Architect/Engineer.
- E. Engineer, Architect and Owner reserve the right to reject submissions of materials, work, or subcontractors that do not, in their opinion, meet the requirements of Drawings, Specifications or job conditions.
- F. Materials and subcontractors used for work on the Project shall be in accordance with accepted material list.
 - 1. The list is intended to assure use of materials and vendors acceptably equivalent to those specified and is not a substitution sheet or complete listing of required materials or services.

2. Substitutions for listed items will not be allowed, except when termed acceptable, in writing by the Architect/Engineer, provided that substitution will result in a cost savings to the Owner , determined by the Owner to be a better product,or is made necessary due to unavailability of listed item. Unavailability shall be confirmed in writing by manufacturer named on accepted list.

1.03 CIVIL AND ARCHITECTURAL WORK SUBCONTRACTORS AND PRODUCTS LIST

BID CATEGORY NO.01 – GENERAL TRADES

NAME OF BIDDER _____

The undersigned hereby submits the following Subcontractors and Products List which becomes a part of the undersigned Contract proposal. Subcontractor purchased material, equipment, and labor shall be under the direct management and control of the Prime Contractor. If a dual listing of manufacturers and subcontractors is herein made, it is understood the Architect/Engineer (not the Contractor) will select the manufacturer or subcontractor of his choice. State the XBE Designation.

CIVIL AND ARCHITECTURAL WORK

<u>Section</u>	<u>Description</u>	<u>Costs \$\$\$</u>	<u>Subcontractor</u>	<u>Manufacturer</u>
02 41 19	Selective Demolition			
05 40 00	Cold-Formed Metal Framing			
05 50 00	Metal Fabrications			
06 10 00	Rough Carpentry			
06 41 16	Plastic-Laminate-Faced Architectural Cabinets			
06 46 00	Wood Trim			
07 21 00	Thermal Insulation			
07 51 13	Built-Up Asphalt Roofing			
07 62 00	Sheet Metal Flashing and Trim			
07 72 00	Roof Accessories			
07 84 13	Penetration Firestopping			

<u>Section</u>	<u>Description</u>	<u>Costs \$\$\$</u>	<u>Subcontractor</u>	<u>Manufacturer</u>
07 92 00	Joint Sealants			
08 11 13	Hollow Metal Doors and Frames			
08 14 16	Flush Wood Doors			
08 41 13	Aluminum-Framed Entrances and Storefronts			
08 71 00	Door Hardware			
08 71 00	KPC Loy Norrix Clinic 08 71 00 Door Hardware 2024-03-11 REV 1 (1)			
08 80 00	Glazing			
09 22 16	Non-Structural Metal Framing			
09 29 00	Gypsum Board			
09 30 00	Tiling			
09 65 00	Resilient Flooring			
09 91 23	Interior Painting			
10 11 00	Visual Display Units			
10 28 00	Toilet, Bath, and Laundry Accessories			
10 44 13	Fire Protection Cabinets			
10 44 16	Fire Extinguishers			

Name of Bidder:	Date:
Address:	
City/State/Zip:	
Telephone:	
By:	

1.04 MECHANICAL WORK SUBCONTRACTORS AND PRODUCTS LIST

BID CATEGORY NO.02 – MECHANICAL

NAME OF BIDDER _____

The undersigned hereby submits the following Subcontractors and Products List which becomes a part of the undersigned Contract proposal. Subcontractor purchased material, equipment, and labor shall be under the direct management and control of the Prime Contractor. If dual listing of manufacturers or subcontractors is herein made, it is understood the Architect/Engineer (not the Contractor) will select the manufacturer or subcontractor of his choice.

MECHANICAL WORK

<u>Section</u>	<u>Description</u>	<u>Costs \$\$\$</u>	<u>Subcontractor</u>	<u>Manufacturer</u>
02 41 19	Selective Demolition			
22 05 00	Common Work Results for Plumbing			
22 05 23	General Duty Valves for Plumbing Piping			
22 05 29	Hangers and Supports for Plumbing Piping and Equipment			
22 05 53	Identification for Plumbing Piping and Equipment			
22 07 00	Plumbing Insulation			
22 08 00	Commissioning of Plumbing			
22 11 16	Domestic Water Piping			
22 11 19	Domestic Water Piping Specialties			
22 13 16	Sanitary Waste and Vent Piping			
22 13 19	Sanitary Waste Piping Specialties			

<u>Section</u>	<u>Description</u>	<u>Costs \$\$\$</u>	<u>Subcontractor</u>	<u>Manufacturer</u>
22 40 00	Plumbing Fixtures			
23 05 00	Common Work Results for HVAC			
23 05 13	Common Motor Requirements for HVAC Equipment			
23 05 53	Identification for HVAC Piping and Equipment			
23 05 93	Testing, Adjusting, and Balancing for HVAC			
23 07 00	HVAC Insulation			
23 08 00	Commissioning of HVAC			
23 09 00	Instrumentation and Control for HVAC			
23 11 23	Facility Natural Gas Piping			
23 31 13	Metal Ducts			
23 33 00	Air Duct Accessories			
23 34 23	HVAC Power Ventilators			
23 36 00	Air Terminal Units			
23 37 13	Diffusers, Registers, and Grilles			
23 40 00	Antimicrobial Systems for HVAC			
23 74 13	Packaged, Outdoor, Central-Station Air- Handling Units			

Plumbing Fixtures:

Manufacturer:

a) _____

b) _____

c) _____

d) _____

e) _____

f) _____

g) _____

h) _____

i) _____

j) _____

k) _____

l) _____

Name of Bidder:	Date:
Address:	
City/State/Zip:	
Telephone:	
By:	

1.05 ELECTRICAL WORK SUBCONTRACTORS AND PRODUCTS LIST

BID CATEGORY NO.03 ELECTRICAL

NAME OF BIDDER _____

The undersigned hereby submits the following Subcontractors and Products List which becomes a part of the undersigned Contract proposal. Subcontractor purchased material, equipment, and labor shall be under the direct management and control of the Prime Contractor. If dual listing of manufacturers or subcontractors is herein made, it is understood the Architect/Engineer (not the Contractor) will select the manufacturer or subcontractor of his choice.

ELECTRICAL WORK

<u>Section</u>	<u>Description</u>	<u>Costs \$\$\$</u>	<u>Subcontractor</u>	<u>Manufacturer</u>
02 41 19	Selective Demolition			
26 05 00	Common Work Results for Electrical			
26 05 19	Low-Voltage Electrical Power Conductors and Cables			
26 05 26	Grounding and Bonding for Electrical Systems			
26 05 29	Hangers and Supports for Electrical Systems			
26 05 33	Raceways and Boxes for Electrical Systems			
26 05 44	Sleeves and Sleeve Seals for Electrical Raceways and Cabling			
26 05 53	Identification for Electrical Systems			

26 08 00	Minimum Commissioning of Electrical Systems			
26 09 23	Lighting Control Devices			
26 09 43	Lighting Control System			
26 27 26	Wiring Devices			
26 29 13	Enclosed Controllers			
26 29 23	Variable Frequency Motor Controllers			
26 51 00	Interior Lighting			
27 05 00	Common Work Results for Communications			
27 05 26	Grounding and Bonding for Communications Systems			
27 05 28	Pathways for Communications Systems			
27 05 53	Identification for Communications Systems			
27 15 13	Communications Copper Horizontal Cabling			
27 17 00	Testing, ID and Admin of Balanced Twisted Pair Infrastructure			
27 51 16	Public Address Systems			
28 31 00	Fire Detection and Alarm			

Name of Bidder:	Date:
Address:	
City/State/Zip:	
Telephone:	
By:	

END OF SECTION 00 43 50

SECTION 01 12 00 - MULTIPLE CONTRACT SUMMARY

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Prime Contract, including amended General Conditions and other Division 1 Specification Sections, apply to Work of this Section.

1.02 SUMMARY

- A. The intent of this Section is to indicate the Work required by the Contractors and to provide information regarding the duties, responsibilities, and cooperation required by the Contractors, with similar requirements for the subcontractors and suppliers.
- B. Owners right to maintain current operations
- C. Occupancy requirements
- D. Work by Owner
- E. Permits, fees, and notices
- F. Labor and materials
- G. Verifications of existing dimensions
- H. Project security
- I. Coordination of work
- J. Time of commencement and completion
- K. Schedule of contract responsibilities

1.03 WORK UNDER SEPARATE CONTRACTS

- A. Prime Contracts are defined to include the following contracts described in the Schedule of Contract Responsibilities included hereinafter; and each is recognized to be a major part of the project, with Work to be performed concurrently and in close coordination with Work of other Prime Contracts.
- B. The "Contract Documents," as defined in the General Conditions, include "the Drawings." Although Drawings are grouped and identified by classification of the Work, Contractors shall be responsible for their Work as specified herein and as

indicated on the Drawings. Although the majority of the Drawings are "to scale," Contractors are directed to use indicated dimensions for determining material quantities and for other reasons. No additional monies will be allowed due to Contractors using "scaling instruments" to determine material quantities or for other reasons.

- C. Separate prime contracts will be awarded as per the **"Schedule of Contract Responsibilities"** (see Part 3 – Execution). Contractors shall include Work required by the Specifications and Drawings for each contract area defined in the Schedule.
- D. Work for the complete construction of the Project will be under multiple prime contracts with the Owner. The Construction Manager will manage the construction of the Project.
- E. Each Contractor shall be responsible for demolition and disposal of existing items relative to his Contract.

1.04 ADMINISTRATIVE RESPONSIBILITIES OF PRIME CONTRACTORS AND CM

- A. The Construction Manager shall be responsible for the maintenance of the Construction Schedule and management of every phase of the Work.
 - 1. Each Contractor shall read the Specifications and Drawings for other separate Contracts for fixed equipment and the like to be incorporated or attached or built in to the Work; and familiarize himself with the requirements and responsibilities of other Contracts to enable the required coordination and supervision.
 - 2. Each Contractor shall also familiarize himself with other items to be incorporated into the Work including equipment and Work by the Owner.
 - 3. Each Contractor shall cooperate with the Construction Manager in notifying him when the Work is at a stage to require the services of other Contractors and shall notify the Construction Manager in the event that such other Contractors do not carry out their responsibilities in connection with such notification.
- B. Contractors shall cooperate with and assist the Construction Manager in the preparation of construction progress and procedures, schedule of product deliveries, and their effect on the overall project progress and completion. Other Contractors shall cooperate in getting their Work and the Work of their subcontractors completed according to the schedule as prepared and maintained by the Construction Manager. Each Contractor shall immediately notify the Construction Manager of a delay in delivery of products or the scheduled date of completion that may affect the total progress of construction.
- C. The Owner will furnish the topographical survey, either as a part of these Drawings or separately, giving the general topographical lines existing at the site and the property lines.

- D. Contractors required to make connections to existing utilities, especially sewerage where gravity flow occurs, shall verify grades and locations at points of such connections and shall notify the Construction Manager of circumstances which would adversely affect the proper flow or connection to such facilities.

1.05 PRIME CONTRACTORS USE OF PREMISES

- A. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.
 - 1. Owner Occupancy: Allow for Owner occupancy and use by the public.
 - 2. Driveways and Entrances: Keep driveways and entrances serving the premises clear and available to the Owner, the Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.
- B. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.06 OWNERS RIGHT TO MAINTAIN OPERATIONS

- A. During the course of this Project, normal and customary functions and operations must be maintained. The Contract Documents are intended to define a strict separation between the school activities of students and staff from the activities of the construction project.
- B. The Construction Manager, Architect, and Owner will not tolerate any visible or audible actions initiated or responded to by any employees of Contractors on this Project toward any students, teachers, or staff members at the school system. Violators shall be promptly removed from the site.
- C. The Owner intends to instruct students, teachers, and staff to refrain from communications with Contractor's personnel working on this Project. All communication with Owner and staff shall be through the Construction Manager.

- D. Contractors must expend their best effort toward protection of the health, safety, and welfare of occupants on the Owner's property during the course of Work on this Project.
- E. Contractors and Subcontractors shall be subject to such rules and regulations for the conduct of the Work as the Owner may establish. Employees shall be properly and completely clothed while working. Bare torsos, legs and feet will not be allowed. Possession or consumption of alcoholic beverages or drugs, tobacco or other noxious behavior on the site is strictly prohibited. Violators shall be promptly removed from the site. Smoking is not permitted on school property or within school buildings.

1.07 OCCUPANCY REQUIREMENTS

- A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the Owner's operations.
- B. Partial Owner Occupancy: The Owner reserves the right to occupy and to place and install equipment in completed areas of the building prior to Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.
 - 1. The Construction Manager will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner occupancy.
 - 2. Party which obtained general building permit shall obtain a Certificate of Occupancy from local building officials prior to Owner occupancy.
 - 3. Prior to partial Owner occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy, the Owner will operate and maintain mechanical and electrical systems serving occupied portions of the building.
 - 4. Upon occupancy, the Owner will assume responsibility for maintenance and custodial service for occupied portions of the building.

1.08 WORK BY OWNER

- A. The Owner intends to complete the following items of Work outside the provisions of these Contract Documents. Contractors shall not restrict or interfere with the Owner's right to the Project to accomplish this Work.
 - 1. Equipment and furniture except as scheduled and specified under Divisions 11 and 12 and shown on the Drawings.
 - 2. Items which may be deleted from Contracts for Work as required by the Contract Documents.
 - 3. Existing school maintenance work.

4. The purchase and supplying of certain materials as noted in the Project Manual.
5. The Owner, under separate contract, shall provide removal of identified asbestos containing materials from the existing structure. The asbestos report is available through the Construction Manager upon request.
6. (List other items as may be applicable).

1.09 PERMITS, FEES, AND NOTICES

- A. The Construction Manager will secure the general building permit for the Owner. Each Contractor shall secure and pay for other permits, governmental fees, and licenses necessary for the proper execution and completion of the Contractors Work. Fees to relocate utilities on Owner's property shall be included in the bid of the Contractor doing the relocation.
 1. The Owner shall pay for the cost of the Building Permit.
 2. State filing fees for plan approval are the responsibility of the Owner and will be paid by the Owner.
- B. Utility Tie-Ins: Shall be arranged with local utility company and other involved parties for minimum interruption of service.
- C. Shutdowns of existing systems shall be limited to minimum time required and scheduled with other involved parties. Provide 2 days written notice of shutdown to Construction Manager and Owner.
- D. Inspections of installed work shall be performed by the governing authority as arranged for by the Contractor. Work shall not be covered until approved.
- E. Each Contractor shall give notices and comply with laws, ordinances, rules, regulations, and orders of public authorities bearing on the performance of his Work. If a Contractor observes that the Contract Documents are at variance therewith, he shall promptly notify the Construction Manager in writing, and necessary changes shall be adjusted by appropriate notification. If a Contractor performs Work knowing it to be contrary to such laws, ordinances, rules, and regulations, and without such notice to the Construction Manager, he shall assume full responsibility therefore and shall bear the costs attributable thereto.

1.10 LABOR AND MATERIALS

- A. Unless otherwise specifically noted, the Contractor shall provide and pay for 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 his Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

- B. Each Contractor shall enforce strict discipline and good order among his employees or other persons carrying out Work of his Contract and shall not permit employment of unfit person or persons or anyone not skilled in the task assigned to them.
- C. Prime Contractors must furnish a letter to the Construction Manager, stating that Contractor shall not assign any of its employees, agents or other individuals to perform any services in the District's facilities or program sites if that individual:
 - 1. Is listed on the Michigan Sex Offender Registry, www.mipsor.state.mi.us.
 - 2. Is listed on the Federal Sex Offender Registry www.nsopw.gov.
 - 3. Has not passed a 5-50 drug screen, testing negative for the following drugs:
 - a. Amphetamines
 - b. Methamphetamines
 - c. Cocaine
 - d. Codeine
 - e. Methadone
 - f. Morphine
 - g. Phencyclidine (PCP)
 - h. Marijuana
- D. ID Stickers will be issued by The Skillman Corporation upon receipt of verification from the Contractor that the employee/subcontractor employee or independent contractor has a satisfactory record to work on the Project. Stickers will be numbered and numbers assigned to each worker to be worn on their hardhat. It is the Contractor's responsibility to maintain a record of contractor's name assigned each number and provide to The Construction Manager upon request.
- E. Consistent with Michigan law, possession or consumption of drugs on school property will promptly be reported to the local police. Consumption of alcoholic beverages or tobacco or other noxious behavior on school owned property is strictly prohibited. Violators shall be promptly removed from the site. Smoking is not permitted on school property or within school buildings.

1.11 CUTTING AND PATCHING

- A. Refer to Section 01 73 10 – Cutting and Patching, for provisions on this subject.

1.12 VERIFICATIONS OF EXISTING DIMENSIONS

- A. When verification of existing dimensions is required, the Contractor requiring said verification for the construction or fabrication of his material shall be the Contractor responsible for the procurement of the field information.

1.13 PROJECT SECURITY

- A. Each Prime Contractor shall take all reasonable precautions to prevent injury, damage or loss to people and property in, on and adjacent to the project. This shall

include not only their own work or property but that of other contractors and the Owner.

- B. If deemed necessary by The Construction Manager a project wide security program may be developed for the purpose of preventing damage or loss at the project site or property adjacent thereto. Once accepted by the Owner, contractors shall comply.

1.14 SCHEDULE OF CONTRACT RESPONSIBILITIES - SCOPE

- A. Contractors shall submit their proposals based on the work included under each contract area as listed herein. Include Work necessary for a complete project, as shown on the Drawings and called for in the Specifications.
- B. Questions concerning the phasing or "Schedule of Contract Responsibilities" should be directed to the Construction Manager, who will be the interpreter and be responsible for this Schedule of Contract Responsibilities and Contract Breakdown, prior to submitting proposals and during construction.
- C. The requirements of Division 1 are a part of the Work of each and every contract area. The Contractor for any one contract area shall be familiar with the Work and requirements of all other contract areas.
- D. Certain Specification Sections describe Work to be performed under several contract areas. (Example: 06 10 00 - Rough Carpentry.) Provide Work of this nature as required for each contract area whether or not enumerated in the Schedule of Contract Responsibilities.
- E. The following contract areas are broken down by Specifications Section conforming basically to the CSI format.
- F. The Drawings and Specifications as furnished for each of the Contracts is for the convenience of the Contractor in preparing a proposal for this Project. However, each Contractor is responsible to review the complete set of Drawings and Specifications to assure that Work required to be installed to complete his phase of the Work is included in his proposal. This "Schedule of Contract Responsibilities" is a definition of the work as it is to be bid in separate contracts. Where a specific item of Work is not defined, but is normally inherent to a trade, or is included in the scope of the applicable technical revision, it will be the responsibility of that Contractor to include the Work in his proposal.
- G. This "Schedule of Contract Responsibilities" is to aid each Contractor in defining the Scope of Work to be included in his proposal. However, omissions from this "Schedule of Responsibilities" do not relieve the Contractor from including in his proposal that Work which will be required to complete his Contract. Each Contractor should read the "Schedule of Contract Responsibilities" completely to familiarize himself with the Work of other Contractors that may have Work in

adjacent areas and to coordinate the interfacing problems that may occur as the work is assembled and constructed.

- H. Where specific Work is to be completed under a particular phase of the Project and the Work is wholly or partially completed by other trades because of the type of work involved or jurisdictional trade agreements, the Contractor will be responsible to subcontract the Work as necessary to complete the Work included in his Contract. No delay in the Work will be allowed due to the failure of the Contractor to subcontract related work required by jurisdictional trade agreements.

1.15 COORDINATION OF WORK

- A. Each Contractor is responsible to coordinate his Work with the Work of other trades and other Contractors and requirements of the school system. The Contractor must make space allowances for Work of other Contractors, provide necessary openings where indicated or implied by the Drawings and Specifications. Each Contractor is responsible to protect his own Work.

1.16 TIME OF COMMENCEMENT AND COMPLETION

- A. The Contractor shall commence work within ten (10) days after being notified in writing to proceed and shall complete the Work within the time limitations established in the Form of Agreement.
1. It is anticipated that construction will start within **30** calendar days after receipt of bids.
 2. Construction shall be complete within **143** consecutive calendar days, or earlier, after Notice to Proceed.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 SCHEDULE OF CONTRACT RESPONSIBILITIES

3.02 GENERAL REQUIREMENTS

- A. PROVIDED BY OWNER THROUGH THE CONSTRUCTION MANAGER
- | | | |
|---------|-----------|-----------------------------|
| Section | 01 32 00 | Schedules and Reports |
| Section | 01 45 00S | Masonry Inspection Report |
| Section | 01 45 10 | Testing Laboratory Services |
| Section | 01 57 60 | Project Signs |
| Section | 01 71 50 | Final Cleaning |
- B. PROVIDED BY ALL CONTRACTORS AS APPLICABLE
- | | | |
|---------|----------|----------------------------------|
| Section | 01 12 00 | Multiple Contract Summary |
| Section | 01 2 300 | Alternates |
| Section | 01 25 00 | Contract Modification Procedures |

Section	01 28 00	Schedule of Values
Section	01 29 00	Applications for Payment
Section	01 31 00	Project Meetings
Section	01 32 00	Schedules and Reports
Section	01 33 00	Submittal Procedures
Section	01 45 10	Testing Laboratory Services (Paragraph 1.05)
Section	01 50 50	Temporary Facilities and Controls
Section	01 54 60	Environment Protection
Section	01 54 80	Utility Protection
Section	01 56 30	Water Control
Section	01 56 90	Housekeeping & Safety
Section	01 59 20	Offices and Sheds
Section	01 60 00	Product Requirements
Section	01 72 50	Work Layout
Section	01 73 10	Cutting and Patching
Section	01 77 00	Contract Closeout

All Contractors shall provide their Superintendents with radios capable of handling multiple channels and compatible with radios used by the Construction Manager.

Autodesk Build is replacing **PlanGrid**. **Autodesk Build** does not require users to purchase a license. **Contractors** will be invited to the project and required to use this tool. **Autodesk Build** will be used as the **Current Set** and **As-Built Record Drawings**. Additionally, it will be used to track **Issues for Safety, QA/QC, Non-Compliance Issues, Work Completion List** and **Punch List**.

C. PROVIDED BY DESIGNATED CONTRACTORS

Section	01 21 00	Allowances
Section	01 51 10	Temporary Electricity, Lighting and Warning Systems
Section	01 51 30	Temporary Heating, Ventilation and Cooling
Section	01 51 50	Temporary Water
Section	01 51 60	Temporary Sanitary Facilities
Section	01 51 80	Temporary Fire Protection
Section	01 52 10	Construction Aids and Temporary Enclosures
Section	01 52 60	Rubbish Container
Section	01 53 10	Fences (Temporary Security)
Section	01 53 30	Barricades
Section	01 55 00	Access Roads and Parking Areas

3.03 **BID CATEGORIES**

A. **BID CATEGORY NO. 1 – GENERAL TRADES**

General Requirements in Paragraph 3.02.B above.

Section	02 41 19	Selective Demolition
Section	05 40 00	Cold-Formed Metal Framing
Section	05 50 00	Metal Fabrications
Section	06 10 00	Rough Carpentry
Section	06 41 16	Plastic-Laminate-Faced Architectural Cabinets
Section	06 46 00	Wood Trim
Section	07 21 00	Thermal Insulation
Section	07 51 13	Built-Up Asphalt Roofing
Section	07 62 00	Sheet Metal Flashing and Trim
Section	07 72 00	Roof Accessories
Section	07 84 13	Penetration Firestopping
Section	07 92 00	Joint Sealants
Section	08 11 13	Hollow Metal Doors and Frames
Section	08 14 16	Flush Wood Doors
Section	08 41 13	Aluminum-Framed Entrances and Storefronts
Section	08 71 00	Door Hardware
Section	08 71 00	KPC Loy Norrix Clinic 08 7100 Door Hardware 2024-03-11 REV 1 (1)
Section	08 80 00	Glazing
Section	09 22 16	Non-Structural Metal Framing
Section	09 29 00	Gypsum Board
Section	09 30 00	Tiling
Section	09 65 00	Resilient Flooring
Section	09 91 23	Interior Painting
Section	10 11 00	Visual Display Units
Section	10 28 00	Toilet, Bath, and Laundry Accessories
Section	10 44 13	Fire Protection Cabinets
Section	10 44 16	Fire Extinguishers

B. **BID CATEGORY NO. 2 – MECHANICAL**

General Requirements in Paragraph 3.02.B above.

Section	02 41 19	Selective Demolition
Section	22 05 00	Common Work Results for Plumbing
Section	22 05 23	General Duty Valves for Plumbing Piping
Section	22 05 29	Hangers and Supports for Plumbing Piping and Equipment
Section	22 05 53	Identification for Plumbing Piping and Equipment
Section	22 07 00	Plumbing Insulation
Section	22 08 00	Commissioning of Plumbing
Section	22 11 16	Domestic Water Piping
Section	22 11 19	Domestic Water Piping Specialties
Section	22 13 16	Sanitary Waste and Vent Piping
Section	22 13 19	Sanitary Waste Piping Specialties

Section	22 40 00	Plumbing Fixtures
Section	23 05 00	Common Work Results for HVAC
Section	23 05 13	Common Motor Requirements for HVAC Equipment
Section	23 05 53	Identification for HVAC Piping and Equipment
Section	23 05 93	Testing, Adjusting, and Balancing for HVAC
Section	23 07 00	HVAC Insulation
Section	23 08 00	Commissioning of HVAC
Section	23 09 00	Instrumentation and Control for HVAC
Section	23 11 23	Facility Natural Gas Piping
Section	23 31 13	Metal Ducts
Section	23 33 00	Air Duct Accessories
Section	23 34 23	HVAC Power Ventilators
Section	23 36 00	Air Terminal Units
Section	23 37 13	Diffusers, Registers, and Grilles
Section	23 40 00	Antimicrobial Systems for HVAC
Section	23 74 13	Packaged, Outdoor, Central-Station Air-Handling Units

C. BID CATEGORY NO. 3 – ELECTRICAL

General Requirements in Paragraph 3.02.B above.

Section	02 41 19	Selective Demolition
Section	26 05 00	Common Work Results for Electrical
Section	26 05 19	Low-Voltage Electrical Power Conductors and Cables
Section	26 05 26	Grounding and Bonding for Electrical Systems
Section	26 05 29	Hangers and Supports for Electrical Systems
Section	26 05 33	Raceways and Boxes for Electrical Systems
Section	26 05 44	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
Section	26 05 53	Identification for Electrical Systems
Section	26 08 00	Minimum Commissioning of Electrical Systems
Section	26 09 23	Lighting Control Devices
Section	26 09 43	Lighting Control System
Section	26 27 26	Wiring Devices
Section	26 29 13	Enclosed Controllers
Section	26 29 23	Variable Frequency Motor Controllers
Section	26 51 00	Interior Lighting
Section	27 05 00	Common Work Results for Communications
Section	27 05 26	Grounding and Bonding for Communications Systems
Section	27 05 28	Pathways for Communications Systems
Section	27 05 53	Identification for Communications Systems
Section	27 15 13	Communications Copper Horizontal Cabling
Section	27 17 00	Testing, ID and Admin of Balanced Twisted Pair Infrastructure
Section	27 51 16	Public Address Systems

Section 28 31 00 Fire Detection and Alarm

END OF SECTION 01 12 00

ADDENDUM NO. 1

DATE OF ISSUANCE: March 29, 2024

PROJECT: Loy Norrix High School Health Suite
606 East Kilgore Road
Kalamazoo, MI 49001

OWNER: Kalamazoo Public Schools

ARCHITECT'S PROJECT NO.: 23-613.00

ORIGINAL BID ISSUE DATE: March 8, 2024

SCOPE OF WORK

This Addendum includes changes to, or clarifications of, the original Bidding Documents and any previously issued addenda, and shall be included in the Bid. All of these Addendum items form a part of the Contract Documents. The Bidder shall acknowledge receipt of this Addendum in the appropriate space provided on the Bid Form. Failure to do so may result in disqualification of the Bid.

DOCUMENTS INCLUDED IN THIS ADDENDUM

This Addendum includes **[2]** two pages of text and the following documents:

- Bidding Documents: **None.**
- Contract Conditions: **None.**
- Specification Sections: **Project Manual**
- Drawings: **None.**

CHANGES TO PREVIOUSLY ISSUED ADDENDA

None.

CHANGES TO BIDDING REQUIREMENTS

None.

CHANGES TO CONTRACT CONDITIONS

None.

CHANGES TO SPECIFICATIONS

ADD-1 Item No. S-1 - Project Manual Updated

Refer to Specification Section: Please see new project manual

Update of entire project manual. This is to replace the previously issued project manual specification set.

CHANGES TO DRAWINGS

None.

END OF ADDENDUM.

KPS LOY NORRIX HIGH SCHOOL HEALTH SUITE

PROJECT MANUAL

ADD #1 - 03-28-2024

OWNER

KALAMAZOO PUBLIC SCHOOLS

1220 HOWARD STREET
KALAMAZOO, MICHIGAN 49008

PROJECT NUMBER

Architect's Project No. 23-612.00

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Refer to Construction Manager's Project Manual issued by <Construction Manager> for additional procurement, contracting, and general requirements

PROJECT FILES

Specification Section Matrix-2023-clean
Specifications Yes-Maybe-No Guide Template 2023-1107

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NOT USED

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NOT USED

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NOT USED

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NOT USED

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NOT USED

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NOT USED

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NOT USED

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NOT USED

PROJECT NO. 23-612.00

**KPS LOY NORRIX HIGH SCHOOL HEALTH SUITE
KALAMAZOO PUBLIC SCHOOLS**

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ADD #1 - 03-28-2024

DIVISION 48 — ELECTRICAL POWER GENERATION

NOT USED

OUTLINE SPEC

NOT USED

SECTION 00 4325 - SUBSTITUTION DURING PROCUREMENT REQUEST FORM

1.1 INTRODUCTORY INFORMATION

- A. Date: _____
- B. Requesting substitution of _____
- C. As specified in Section _____
- D. Requested Substitute Product: _____

1.2 SUBMITTING PARTY'S STATEMENT

- A. Circle "Y" for yes and "N" for no for each of the following statements and submit supporting data. Indicate impact for all statements below answered as no, with supporting data:
1. (Y) (N) Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 2. (Y) (N) Requested substitution does not require extensive revisions to the Contract Documents.
 3. (Y) (N) Requested substitution is consistent with the Contract Documents and will produce indicated results.
 4. (Y) (N) Substitution request is fully documented and properly submitted in accordance with "Product Substitution" and "Submittals" Articles in Division 01 Section "Product Requirements."
 5. (Y) (N) Requested substitution will not adversely affect Contractor's Construction Schedule.
 6. (Y) (N) Requested substitution has received necessary approvals of authorities having jurisdiction.
 7. (Y) (N) Requested substitution is compatible with other portions of the Work.
 8. (Y) (N) Requested substitution has been coordinated with other portions of the Work.
 9. (Y) (N) Requested substitution provides specified warranty.
- B. I hereby certify that the above statements are true.

Submitter's signature

END OF DOCUMENT 00 4325

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SECTION 00 6324 - BIM TRANSFER WAIVER

INTENT

- A. This document amends and supplements the Digital Data Licensing Agreement AIA C106 - 2013 for requests for BIM Model from the Architect. All provisions which are not so amended or supplemented remain in full force and effect.
- B. At the request of the Contractor, subcontractor, lower-tier subcontractor, or material supplier, and receipt of signed copy of Digital Data Licensing Agreement AIA C106, the Architect will transmit or send BIM model(s) requested.

C. MODIFICATIONS TO AIA C106

D. ARTICLE 3 – LICENSE CONDITIONS

- E. Add the following clauses after the first sentence in Article 3:
 - 1. We make no representation as to the compatibility of these files with your hardware or your software beyond the specified release of the referenced specifications.
 - 2. Data contained on these electronic files are part of our instruments of service and shall not be used by you or anyone else receiving this data through or from you for any purpose other than as a convenience in the support of construction coordination for the referenced project. Any other use or reuse by you or by others will be at your sole risk and without liability or legal exposure to Tower Pinkster Titus Associates. You agree to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against us, our officers, directors, employees, agents or subconsultants that may arise out of or in connection with your use of the electronic files.
 - 3. Furthermore, you shall, to the fullest extent permitted by law, indemnify and hold us harmless against all damages, liabilities or costs, including reasonable attorneys' fees and defense costs, arising out of or resulting from your use of these electronic files.
 - 4. These electronic files are not construction documents. Differences may exist between these electronic files and corresponding hard-copy construction documents. We make no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the hard-copy construction documents prepared by us and the electronic files, the hard-copy construction documents shall govern. You are responsible for determining if any conflict exists. By your use of these electronic files, you are not relieved of your duty to fully comply with the contract documents, including, and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, verify field conditions and coordinate your work with that of other contractors for the project.
 - 5. Because information presented on the electronic files can be modified, unintentionally or otherwise, we reserve the right to remove all indicia of ownership and/or involvement from each electronic display.

END OF DOCUMENT 00 6324

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SECTION 00 6325 - SUBSTITUTION DURING CONSTRUCTION REQUEST FORM

1.1 INTRODUCTORY INFORMATION

- A. Date: _____
- B. Requesting substitution of _____
- C. As specified in Section _____
- D. Requested Substitute Product: _____

1.2 SUBMITTING PARTY'S STATEMENT

- A. Circle "Y" for yes and "N" for no for each of the following statements and submit supporting data. Indicate impact for all statements below answered as no, with supporting data:
1. (Y) (N) Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 2. (Y) (N) Requested substitution does not require extensive revisions to the Contract Documents.
 3. (Y) (N) Requested substitution is consistent with the Contract Documents and will produce indicated results.
 4. (Y) (N) Substitution request is fully documented and properly submitted in accordance with "Product Substitution" and "Submittals" Articles in Division 01 Section "Product Requirements."
 5. (Y) (N) Requested substitution will not adversely affect Contractor's Construction Schedule.
 6. (Y) (N) Requested substitution has received necessary approvals of authorities having jurisdiction.
 7. (Y) (N) Requested substitution is compatible with other portions of the Work.
 8. (Y) (N) Requested substitution has been coordinated with other portions of the Work.
 9. (Y) (N) Requested substitution provides specified warranty.
- B. I hereby certify that the above statements are true.

Submitter's signature

1.3 CONTRACTOR'S STATEMENT

- A. I have reviewed this substitution request and am in agreement with the information presented and statements made. This proposal is complete, and there will be no further charges to the Owner as a result of the acceptance of this substitution.

Contractor's signature

END OF DOCUMENT 00 6325

SECTION 01 4200 - REFERENCES

PART 1 - GENERAL

1.1 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.

1.2 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.
- 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.

- D. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the organizations responsible for 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)
CFR	Code of Federal Regulations
DOD	Department of Defense Military Specifications and Standards
DSCC	Defense Supply Center Columbus (See FS)
FED-STD	Federal Standard (See FS)
FS	Federal Specification
FTMS	Federal Test Method Standard (See FS)
MIL	(See MILSPEC)
MIL-STD	(See MILSPEC)
MILSPEC	Military Specification and Standards
UFAS	Uniform Federal Accessibility Standards

1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations and Code Agencies: 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."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 4200

SECTION 01 6000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. Related Sections include the following:
 - 1. Division 01 Section "References" for applicable industry standards for products specified.
 - 2. Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
 - 3. Divisions 02 through 49 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.2 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.3 SUBMITTALS

- A. Substitution Requests: Not Permitted

- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

- B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

- C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
 - 3. Refer to Divisions 02 through 49 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected," Architect will make selection.
 - 5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
 - 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
 - 7. General: All materials and products shall be free from asbestos.
- B. Product Selection Procedures:
 - 1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
 - 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
 - 3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
 - 4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
 - 5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
 - 6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements.

- Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
 8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
 9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 - a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
 10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
 - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

- A. Not permitted

2.3 COMPARABLE PRODUCTS

1. Not permitted

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 6000

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SECTION 01 9113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.
- B. Commissioning: Commissioning is a quality oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objective and criteria. The commissioning process includes specific tasks to be conducted during the project in order to verify that design, construction, and training meets the construction/contract documents.
- C. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - 2. Verify and document proper performance of equipment and systems.
 - 3. Verify that O&M documentation left on site is complete.
 - 4. Verify that the Owner's operating personnel are adequately trained.
- D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1.2 ABBREVIATIONS

- A. The following are common abbreviations used in the Specifications and in the Commissioning Plan.

A/E-	Architect and design engineers	GC-	General contractor (prime)
CxA-	Commissioning authority	MC-	Mechanical contractor
CC	Controls contractor	OR-	Owner's Representative
CM-	Construction Manager	PC-	Prefunctional checklist
Cx-	Commissioning	PM-	Project manager (of the Owner)
Cx Plan-	Commissioning Plan document	Subs-	Subcontractors to General
EC-	Electrical contractor	TAB-	Test and balance contractor

1.3 DEFINITIONS

- A. Acceptance Phase: Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.
- B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.

- C. Architect/Engineer (A/E): The prime consultant (architect) and sub-consultants who comprise the design team, generally the HVAC mechanical designer/engineer and the electrical designer/engineer.
- D. Basis of Design (BoD): A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- E. Commissioning Authority (CxA): An independent agent hired by the Owner. The CxA directs and coordinates the day-to-day commissioning activities. The CxA does not take an oversight role like a CM.
- F. Commissioning Plan (Cx Plan): A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process
- G. Deferred Functional Tests : FTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.
- H. Deficiency : A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the design intent).
- I. Factory Testing: Testing of equipment on-site or at the factory by factory personnel with an Owner's representative present.
- J. Functional Performance Test (FT): Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating 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 be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. FTs are performed after prefunctional checklists and startup are complete.
- K. General Contractor (GC): The prime contractor for this project. Generally refers to all the GC's subcontractors as well. Also referred to as the Contractor, in some contexts.
- L. Manual Test: Using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- M. Non-Compliance or Non-Conformance: See Deficiency.
- N. Over-Written Value: Writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50F to 75F to verify economizer operation). See also "Simulated Signal."

- O. Owner's Project Requirements (OPR): A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- P. Prefunctional Checklist (PC): A list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the CxA to the Sub. Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.). However, some prefunctional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). The word prefunctional refers to before functional testing. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist. Even without a commissioning process, contractors typically perform some, if not many, of the prefunctional checklist items a commissioning authority will recommend. However, few contractors document in writing the execution of these checklist items. Therefore, for most equipment, the contractors execute the checklists on their own. The commissioning authority only requires that the procedures be documented in writing, and does not witness much of the prefunctional check listing, except for larger or more critical pieces of equipment.
- Q. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment.
- R. Seasonal Performance Tests: FT that are deferred until the system(s) will experience conditions closer to their design conditions.
- S. Simulated Condition: Condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).
- T. Simulated Signal: Disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.
- U. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- V. Startup: The initial starting or activating of dynamic equipment, including executing prefunctional checklists.
- W. Subs: The subcontractors to the GC who provide and install building components and systems.
- X. Test Procedures: The step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the CxA.
- Y. Trending: Monitoring using the building control system.
- Z. Vendor: Supplier of equipment.
- AA. Warranty Period: Warranty period for entire project, including equipment components.

1.4 COORDINATION

- A. Commissioning Team: The members of the commissioning team consist of the Commissioning authority (CxA), the Owner's Representative (OR), the designated representative of the owner's Construction Management firm (CM), the General Contractor (GC or Contractor), the architect and design engineers (particularly the mechanical engineer), the Mechanical Contractor (MC), the Electrical Contractor (EC), the TAB representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment. If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.
- B. Management: The CxA is hired by the Owner directly. The CxA directs and coordinates the commissioning activities and the reports to the OR. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
- C. Scheduling: The CxA will work with the CM and/or GC according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the CM and/or GC for scheduling commissioning activities. All commissioning activities shall be integrated into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. The CxA will provide the initial schedule of primary commissioning events at the commissioning kick-off meeting. As construction progresses more detailed schedules are developed by the CxA. The Commissioning Plan also provides a format for detailed schedules.

1.5 COMMISSIONING PROCESS

- A. Commissioning Plan: The *Commissioning Plan*, provided as part of the bid documents, is binding on the Contractor. The commissioning plan provides guidance in the execution of the commissioning process. The *Specifications* will take precedence over the *Commissioning Plan*.
- B. Commissioning Process: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 - 1. Commissioning during construction begins with an initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the project commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA, through the Owner or CM, with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve issues.
 - 3. Equipment documentation is submitted to the CxA, through the Owner or CM, during normal submittals, including detailed startup procedures.
 - 4. The construction checklists are to be prepared and completed by the contractor or subcontractor before and during the startup process.
 - 5. Installation verification is executed by the CxA.
 - 6. Construction checklists, installation verification checklists, TAB and startup must be completed before functional performance testing.
 - 7. Items of non-compliance in material, installation, or setup shall be corrected at no expense to the Owner.
 - 8. The contractor ensures that the subcontractors construction checklists are executed and documented and that startup and initial checkouts are performed. The CxA verifies that the TAB,

construction checklists and startups were completed according to the plans. This includes the CxA reviewing TAB reports, construction checklists and startup plans/checklists. This also includes witnessing startup of selected equipment. Any testing failure is to be corrected at no additional cost to the Owner, and a re-test is to be performed, observed, and documented.

9. Draft O&M's are submitted.
10. Owner training plans are submitted.
11. The CxA develops and implements equipment and system functional performance test procedures. The forms and procedures are reviewed by the commissioning team.
12. The functional performance tests are executed by the contractor under the direction of the CxA with the assistance of the facility staff. All results are documented by the CxA.
13. The CxA concurrently with the design team and Owner reviews the O&M documentation for completeness.
14. Commissioning shall be completed before substantial completion except for deferred testing.
15. The contractor develops procedures, reviews, coordinates, and implements the training.
16. Deferred testing is conducted as specified or required.

1.6 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, the Construction Manager (CM) and representatives of the Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA. Required entities include but are not limited to the following:

1. Plumbing.
2. HVAC sheet metal.
3. HVAC piping.
4. Test and Balance.
5. DDC.
6. Electrical.
7. Fire Alarm.

- B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. Representatives of the facility user and operation and maintenance personnel.
3. The Owners Representative. (If Applicable)
4. Architect and engineering design professionals.
5. Construction Manager.

1.7 OWNER'S RESPONSIBILITIES

- A. Provide the OPR documentation to the CxA and Contractor for information and use.

- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
- C. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
- D. Attend commissioning scoping meetings and additional meetings as necessary.

1.8 OWNERS REPRESENTATIVE'S RESPONSIBILITIES (IF APPLICABLE)

- A. The Owner's Representative shall represent the Owner during the commissioning process as follows:
 - 1. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions according to the *Commissioning Plan*.
 - 2. Provide final approval for the completion of the commissioning work.
 - 3. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.
 - 4. Attend commissioning scoping meetings and additional meetings as necessary.

1.9 ARCHITECT/ENGINEERS (AE) RESPONSIBILITIES

- A. The AE shall participate in and perform commissioning process activities including, but not limited to, the following:
 - 1. Attend the commissioning kick-off meeting and selected commissioning team meetings.
 - 2. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.
 - 3. Provide any design narrative and sequence documentation requested by the CxA. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - 4. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
 - 5. Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.

1.10 CONSTRUCTION MANAGER'S (CM) RESPONSIBILITIES

- A. The construction manager shall participate in and perform commissioning process activities including, but not limited to the following:
 - 1. Facilitate the coordination of the commissioning work by the CxA, and, with the GC and CxA, ensure that commissioning activities are being scheduled into the master schedule.
 - 2. Attend commissioning team meetings.
 - 3. Perform the normal review of Contractor submittals.
 - 4. Furnish a copy of all construction documents, addenda, requests for information, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.

5. Review commissioning progress and deficiency reports.
6. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.

1.11 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
 3. Attend commissioning team meetings.
 4. Attend commissioning team meetings held on a monthly basis.
 5. Integrate and coordinate commissioning process activities with construction schedule.
 6. Review commissioning progress and deficiency reports.
 7. Review and accept construction checklists provided by the CxA.
 8. Complete paper or electronic construction checklists as Work is completed and provide to the CxA.
 9. Complete paper or electronic construction checklists as Work is completed and provide to the CxA on a weekly basis.
 10. Review and accept commissioning process test procedures provided by the Commissioning Authority.
 11. Complete commissioning process test procedures.
 12. Include the cost of commissioning in the total contract price.
 13. Coordinate the training of Owner personnel and provide the times and dates of training to the CxA.
 14. Execute seasonal or deferred functional performance testing witnessed by the CxA to facilitate the Cx process.
 15. Provide a list of final settings, setpoints, ranges, schedules, and / or trend logs required by the CxA.
 16. Follow the Commissioning Plan.
 17. Attend commissioning scoping meetings and additional meetings as necessary.
 18. From the red-line drawings, edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the chilled and hot water, condenser water, domestic water, steam and condensate systems; supply, return and exhaust air systems and emergency power system.
 19. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
 20. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CxA.
 21. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
 22. Review test procedures for equipment installed by factory representatives.

1.12 EQUIPMENT SUPPLIERS RESPONSIBILITIES

- A. The equipment suppliers shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
 2. Assist in equipment testing per agreements with Subs.
 3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor.
 4. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.

1.13 CxA'S RESPONSIBILITIES

- A. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractors will provide all tools or the use of tools to start, check-out and functionally test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the CxA.
1. Coordinates and directs the commissioning activities using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
 2. Coordinate the commissioning work and, with the GC and CM, ensure that commissioning activities are being scheduled into the master schedule.
 3. Revise, as necessary, the Commissioning Plan.
 4. Plan and conduct a commissioning meetings.
 5. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
 6. Write and distribute prefunctional tests and checklists.
 7. Perform site visits, as necessary, to observe component and system installations. Attends selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
 8. Approve prefunctional tests and checklist completion by reviewing prefunctional checklist reports and by selected site observation and spot checking.
 9. With necessary assistance and review from installing contractors, write the functional performance test procedures for equipment and systems. This may include energy management control system trending, stand-alone datalogger monitoring or manual functional testing. Submit to CM for review, and for approval if required.
 10. Analyze any functional performance trend logs and monitoring data to verify performance.
 11. Coordinate, witness and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.

12. Maintain a master deficiency and resolution log and a separate testing record.
13. Witness performance testing of smoke control systems by others and all other owner contracted tests or tests by manufacturer's personnel over which the CxA may not have direct control. Document these tests and include this documentation in Commissioning Record in O&M manuals.
14. Oversee the training of the Owner's operating personnel.
15. Compile and maintain a commissioning record and building systems book(s).
16. Review and approve the preparation of the O&M manuals.
17. Provide a final commissioning report.
18. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.

1.14 SYSTEMS TO BE COMMISSIONED

- A. Refer to individual Divisions' commissioning sections for systems that are to be commissioned.
- B. The following systems will be commissioned in this project.

1. Plumbing Systems:
 - a. Domestic water heaters
 - b. Domestic hot water return pumps
 - c. Domestic water pressure booster system
2. HVAC Systems:
 - a. Chillers
 - b. Hydronic pumps
 - c. Hot Water boilers
 - d. Hydronic piping systems
 - e. Ductwork
 - f. Variable frequency drives
 - g. Air handlers
 - h. Packaged AC units
 - i. Terminal units (air)
 - j. Unit heaters
 - k. Heat exchangers
 - l. Computer room units
 - m. Testing, Adjusting and Balancing work
 - n. Chemical treatment systems
 - o. HVAC control system
 - p. Fire and smoke dampers
 - q. Equipment sound control
 - r. Equipment vibration control
 - s. HVAC control system
 - t. Fire and smoke dampers
3. Electrical Systems:
 - a. Sweep or scheduled lighting controls
 - b. Daylight dimming controls

- c. Lighting Controls
- d. Power quality
- e. Security system
- f. Emergency power system
- g. UPS systems
- h. Fire and smoke alarm
- i. Communications system
- j. Variable frequency drives

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Division contractor for the equipment being tested. This includes but is not limited to two-way radios, meters, and data recorders.
- B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and shall be turned over to the Owner at Project closeout.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

- A. Initial Meeting: The CxA, through the Owner/CM will schedule, plan, and conduct an initial commissioning meeting. The Contractor and Contractor's responsible parties are required to attend.
- B. Miscellaneous Meetings. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CxA will plan these meetings and will minimize unnecessary time being spent by Subs.
- C. Training: Before operation and maintenance training, the Contractor shall prepare and submit training plans for all systems to be commissioned. In addition to requirements specified in Division 01 Section "Demonstration and Training" the training plans shall also include the following:

1. Review the OPR and BoD.
2. Review installed systems, subsystems, and equipment.
3. Instructor qualifications.
4. Instructional methods and procedures.
5. Training module outlines and contents.
6. Course materials (including operation and maintenance manuals).
7. Locations and other facilities required for instruction.
8. Training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

3.2 REPORTING

- A. The CxA will provide regular reports to the CM and the OR, with increasing frequency as construction and commissioning progresses. Standard forms are provided and referenced in the Commissioning Plan.
- B. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.
- C. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.
- D. A final summary report (about four to six pages, not including backup documentation) by the CxA will be provided to the CM and OR, focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Prefunctional checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals.

3.3 SUBMITTALS

- A. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning authority. All documentation requested by the CxA will be included by the Subs in their O&M manual contributions.

1. Requested Submittals:
 - a. Air Handling Units
 - b. Automatic Transfer Switch
 - c. Building Automation
 - d. Blower coil Unit – Cooling / Heating

- e. Boiler
- f. Cabinet Unit Heaters
- g. Chiller
- h. Computer Room AC Units
- i. Control Systems
- j. Domestic Water Heaters
- k. Domestic Hot Water Piping Insulation
- l. Ductwork Insulation
- m. Emergency Generator
- n. Exhaust Fans
- o. Fire Alarm System
- p. Heat Exchangers
- q. Hot Water Heating Coils
- r. Lighting Controls
- s. Packaged Terminal Air-Conditioning Units
- t. Pipe Insulation
- u. Pumps
- v. Security / Intrusion detection System
- w. Service Water Heaters
- x. Testing, Adjusting, and Balancing
- y. Terminal Units
- z. VAV Terminal Unit Boxes
- aa. Variable Frequency / Variable Speed Drives

2. Requested Shop Drawings:

- a. Building Distribution Piping
- b. Ductwork
- c. Fire Alarm System
- d. Lighting Control System
- e. Security / Intrusion detection System
- f. Sprinkler System

3. Requested Product Samples:

- a. User Adjustable Thermostats
- b. Combination Smoke-Fire Dampers
- c. Air Volume Control Dampers
- d. Water Flow Control Device
- e. Air Flow Measuring Devices

- B. The Commissioning authority will review and provide comment on submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The Commissioning authority will notify the CM, Owner Representative, or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

- C. The CxA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review and approve them.
- E. Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the Commissioning Authority's review.

3.4 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment to be commissioned. Some systems that are not comprised so much of actual dynamic machinery, e.g., electrical system power quality, may have very simplified PCs and startup.
- B. General. Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
- C. Start-up and Initial Checkout Plan. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms.
 - 1. These checklists and tests are provided by the CxA to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.
 - 2. The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the CxA's checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. The full start-up plan could consist of something as simple as:
 - a. The CxA's prefunctional checklists.
 - b. Manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - c. The manufacturer's normally used field checkout sheets.
 - 3. The full start-up procedures and the approval form may be provided to the CM for review and approval, depending on management protocol.
- D. Sensor and Actuator Calibration.
 - 1. All field-installed temperature, relative humidity, CO, 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 before-hand. 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 need not be field calibrated.

2. 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. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
- b. Sensors without Transmitters--Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.
- c. Sensors with Transmitters--Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
- d. Critical Applications: For critical applications (process, manufacturing, etc.) more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

3. Tolerances, Standard Applications:

<u>Sensor</u>	<u>Required Tolerance (+/-)</u>	<u>Sensor</u>	<u>Required Tol- erance (+/-)</u>
Cooling coil, chilled and conden- ser water temps	0.4F	Flow rates, water	4% of design
AHU wet bulb or dew point	2.0F	Relative humidity	4% of design
Hot water coil and boiler water temp	1.5F	Combustion flue temps	5.0F
Outside air, space air, duct air temps	0.4F	Oxygen or CO ₂ monitor	0.1 % pts
		CO monitor	0.01 % pts
Watt-hour, voltage & amperage	1% of design	Natural gas and oil flow rate	1% of design

Pressures, air, water and gas	3% of design	Steam flow rate	3% of design
Flow rates, air	10% of design	Barometric pressure	0.1 in. of Hg

4. Valve and Damper Stroke Setup and Check.

- a. BAS Readout: For all valve and damper actuator positions checked, verify the actual position against the BAS readout.
- b. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

5. Closure for heating coil valves (NO): Set heating setpoint 20°F above room temperature. Observe valve open. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set heating setpoint to 20°F below room temperature. Observe the valve close. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

6. Closure for cooling coil valves (NC): Set cooling setpoint 20°F above room temperature. Observe the valve close. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 20°F below room temperature. Observe valve open. For pneumatics, by override in the EMS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

E. Execution of Prefunctional Checklists and Startup.

1. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
2. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.
3. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

F. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The form and any outstanding deficiencies are provided to the CxA, Owner, and CM.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Sub or CM. The CxA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The CxA will involve the CM and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely

manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA recommends approval of the execution of the checklists and startup of each system to the CM using a standard form.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the Contractor.

3.5 FUNCTIONAL PERFORMANCE TESTING

- A. This sub-section applies to all commissioning functional testing for all divisions.
- B. Objectives and Scope: The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
 1. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.
 2. Coordination and Scheduling: The Contractor shall provide sufficient notice, regarding their completion schedule for the construction checklists and startup of all equipment and systems to allow the functional performance testing to be scheduled. The commissioning team shall oversee, witness, and document the functional performance of all equipment and systems. The Contractor/subcontractors shall execute the test, the CxA and Owner will witness and direct the tests. Performance testing shall be conducted after the construction checklists, and startup has been satisfactorily completed. The control system shall be sufficiently tested prior to use, to verify performance of other components or systems. The air balancing and water balancing shall be completed before functional testing of air or water related equipment or systems. Testing proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface of coordinated responses between systems shall be checked.
 3. Development of Test Procedures. Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor responsible to execute a test, shall provide assistance to the CxA in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CxA shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA may submit the tests to the A/E for review, if requested.
 4. The CxA shall review owner-contracted, factory testing or required owner acceptance tests which the CxA is not responsible to oversee, including documentation format, and shall determine what further testing or format changes may be required to comply with the Specifications. Redundancy of testing shall be minimized.
 5. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

C. Test Methods:

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities.
2. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
4. Simulated Signal: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
5. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.
6. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.
7. Setup: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
8. Sampling: Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity.
 - a. A common sampling strategy such as the "xx% Sampling - yy% Failure Rule" is defined by the following example:
 - 1) xx = the percent of the group of identical equipment to be included in each sample.
 - 2) yy = the percent of the sample that if failing, will require another sample to be tested.
 - b. The example below describes a 20% Sampling—10% Failure Rule.
 - 1) Randomly test at least 20% (xx) of each group of identical equipment. In no case less than three units in each group. This 20%, or three, constitute the "first sample."
 - 2) If 10% (yy) of the units in the first sample fail the functional performance tests, test another 20% of the group (the second sample).

- 3) If 10% of the units in the second sample fail, test all remaining units in the whole group.
 - 4) If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.
- D. Coordination and Scheduling. The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the CM, GC and affected Subs. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests.
1. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.
- E. Problem Solving. The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the GC, Subs and A/E.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation. The CxA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. CxA is responsible for all documentation of performance testing.
- B. Non-Conformance:
1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the CM on a standard non-compliance form.
 2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
 3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the CM.
 4. As tests progress and a deficiency is identified, the CxA discusses the issue with the contractor.
 - a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
 - 1) The CxA documents the deficiency and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CxA submits the non-compliance reports to the CM for signature, if required. A copy is provided to the Sub and CxA. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
 - 2) The CxA reschedules the test and the test is repeated.

- b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - 1) The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the CM and to the Sub representative assumed to be responsible.
 - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
 - 3) The CxA documents the resolution process.
 - 4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.
 - 5. Cost of Retesting:
 - a. The cost for the Sub to retest a prefunctional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.
 - b. For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply: The CxA and CM will direct the retesting of the equipment once at no "charge" to the GC for their time. However, the CxA's and CM's time for a second retest will be charged to the GC, who may choose to recover costs from the responsible Sub.
 - c. The time for the CxA and CM to direct any retesting required because a specific prefunctional checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be backcharged to the GC, who may choose to recover costs from the party responsible for executing the faulty prefunctional test.
 - d. Refer to the "Sampling" subparagraph above for requirements for testing and retesting identical equipment.
 - 6. The Contractor shall respond in writing to the CxA and CM at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
 - 7. The CxA retains the original non-conformance forms until the end of the project.
 - 8. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.
- C. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CM or OR. In such case, the Contractor shall provide the Owner with the following:
- 1. Within one week of notification from the CM or OR, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CM or OR within two weeks of the original notice.

2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
 3. The CM or OR will determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples of the proposed solution will be installed by the Contractor and the CM will be allowed to test the installations for up to one week, upon which the CM or OR will decide whether to accept the solution.
 5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- D. Acceptance: The CxA notes each satisfactorily demonstrated function on the test form. Final acceptance of the performance test by the Owner is made after review by the CxA and CM, following recommendations by the A/E.

3.7 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the Owner. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.
- B. Seasonal Testing: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CxA witnessing. Any final adjustments to the O&M manuals and as-builds due to the testing will be made.

3.8 TRAINING OF OWNER PERSONNEL

- A. All training shall be coordinated, through the CM, with the CxA.
- B. At the discretion of the CxA, training may occur before functional testing is complete if required by the facility operators to assist the CxA in the functional testing.

3.9 OPERATION AND MAINTENANCE MANUALS

- A. CxA Review and Approval: Prior to substantial completion, the CxA shall review the O&M manuals, documentation and redline as-builds for systems that were commissioned to verify compliance with the Specifications. The CxA will communicate deficiencies in the manuals to the CM, OR and A/E, as requested. Upon a successful review of the corrections, the CxA recommends approval and acceptance of these sections of the O&M manuals to the CM, OR and A/E. The CxA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.

- B. The CxA is responsible to compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders and deliver it to the GC, to be included with the O&M manuals. Three copies of the manuals will be provided. The format of the manuals shall be:
1. Tab I-1 Commissioning Plan.
 2. Tab I-2 Final Commissioning Report. Refer to "Final Report Details" article below..
- C. Final Report Details. The final commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.
- D. Other documentation will be retained by the CxA

3.10 WRITTEN WORK PRODUCTS

- A. The commissioning process generates a number of written work products described in various parts of the Specifications:

<u>Product</u>	<u>Developed By</u>
1. Final commissioning plan	CxA
2. Cx meeting minutes	CxA
3. Commissioning schedules	CxA with GC and CM
4. Equipment documentation submittals	Subs
5. Sequence clarifications	Subs and A/E as needed
5. Prefunctional checklists	CxA
6. Startup and initial checkout plan	Subs and CxA (compilation of existing documents)
7. Startup and initial checkout forms filled out	Subs
8. Final TAB report	TAB
9. Issues log (deficiencies)	CxA
10. Commissioning Progress Record	CxA
11. Deficiency reports	CxA
12. Functional test forms	CxA
13. Filled out functional tests	CxA
14. O&M manuals	Subs
15. Commissioning record book	CxA
16. Overall training plan	CxA and CM
17. Specific training agendas	Subs
18. Final commissioning report	CxA
19. Misc. approvals	CxA

END OF SECTION 01 9113

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SECTION 02 4119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
 - 1. Section 01 7300 "Execution" for cutting and patching procedures.

1.2 DEFINITIONS

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

1.3 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.

1.5 CLOSEOUT SUBMITTALS

- A. Inventory of items that have been removed and salvaged.

1.6 QUALITY ASSURANCE

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

1.7 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. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.
- G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.8 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

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 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. 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.
- C. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- D. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs or video, and templates as appropriate.
 - 1. 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.
 - 2. 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.
- E. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Arrange to shut off utilities with utility companies.
 - 2. 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.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings 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 and leave in place.

- 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 and leave in place.

- 4. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
- B. Temporary Shoring: Design, 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.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

- 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. 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. Temporarily cover openings to remain.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. 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 portable fire-suppression devices during flame-cutting operations.
 - 4. Maintain fire watch during flame-cutting operations.
 - 5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 6. Dispose of demolished items and materials promptly.
- B. 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.
- 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 designated by Owner.
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.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

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

3.7 CLEANING

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.] [and recycle or dispose of them**
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 Section 01 7419 "Construction Waste Management and Disposal."

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- B. Burning: Do not burn demolished materials.
- C. 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 4119

SECTION 05 4000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Ceiling joist framing.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections.
 - 2. Division 09 Section "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

1.2 SUBMITTALS

- A. Product Data: For each type of product and accessory indicated.
- B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: ST33H for minimum base metal thickness of 0.0428 inch and less; ST50H for minimum base metal thickness of 0.0538 inch and greater.
 2. Coating: G60, A60, AZ50, or GF30.
- B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: 50, Class 1 or 2.
 2. Coating: G90.

2.2 CEILING JOIST FRAMING

- A. Steel Ceiling Joist Framing: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with enlarged service holes, with stiffened flanges, and as follows:
1. Stud Depth: 3-5/8 inches unless indicated otherwise.
 2. Minimum Ceiling Joist Base-Metal Thickness: 0.0329 inch.
 3. Flange Width: 1-5/8 inches, minimum.

2.3 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members, unless otherwise indicated.
- B. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- C. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel headless, hooked bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- D. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
- E. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
- F. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

2.4 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.

- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.
- C. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
- D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.
- B. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.
- C. Install framing members in one-piece lengths.
- D. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- E. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- F. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- G. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.
- H. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.2 CEILING JOIST INSTALLATION

- A. Ceiling Joist Installation: Install, align, and securely anchor to construction as indicated on Drawings. Fasten to both flanges of joist track.
 - 1. Space joists not more than 2 inches from abutting walls and at spacings indicated.

2. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.
3. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated. Install web stiffeners to transfer axial loads of walls above.
4. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.3 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 4000

SECTION 05 5000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Miscellaneous steel framing and supports.
2. Shelf angles.
3. Loose bearing and leveling plates.
4. Steel weld plates and angles.
5. Miscellaneous steel trim.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.2 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. 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.

1.3 SUBMITTALS

A. Shop Drawings: Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

B. Templates: For anchors and bolts.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 - 2. Provide allowance for trimming and fitting at site.

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. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.
- B. Ferrous Metals:
 - 1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 2. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
 - 3. Steel Tubing: ASTM A 500, cold-formed steel tubing.
 - 4. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
 - 5. Slotted Channel Framing: Cold-formed metal channels complying with MFMA-3, 1-5/8 by 1-5/8 inches. Channels made from galvanized steel complying with ASTM A 653/A 653M, structural steel, Grade 33, with G90 coating; 0.079-inch nominal thickness.
 - 6. Cast Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.

2.3 FASTENERS

- A. General: Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Cast-in-Place Anchors in Concrete: Threaded or wedge type; 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, hot-dip galvanized per ASTM A 153/A 153M.

- C. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material for Anchors in Exterior Locations: Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.
- C. Galvanizing Repair Paint: SSPC-Paint 20, high-zinc-dust-content paint for regalvanizing welds in steel.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.
- E. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.5 FABRICATION

- A. General: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
 - 1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
 - 2. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
 - 3. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
 - 4. Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish exposed welds smooth and blended.
 - 5. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
 - 6. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
 - 7. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
 - 8. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 24 inches o.c.

- B. Miscellaneous Framing and Supports: Provide steel framing and supports not specified in other Sections as needed to complete the Work. Fabricate units from steel shapes, plates, and bars of welded construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.
- C. Loose Steel Lintels: Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- D. Shelf Angles: Fabricate shelf angles of sizes indicated and for attachment to framing. Fabricate with horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c.
 - 1. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.
- E. Loose Bearing and Leveling Plates: Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts.
 - 1. Finish: Leave unfinished.
- F. Miscellaneous Steel Trim: 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. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.
- B. Steel and Iron Finishes:
 - 1. Hot-dip galvanize items as indicated to comply with ASTM A 123/A 123M or ASTM A 153/A 153M as applicable.
 - 2. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed metal fabrications:
 - 3. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting," for shop painting.
- C. Stainless Steel Finishes: Remove tool and die marks and stretch lines or blend into finish.
 - 1. Bright, Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, with edges and surfaces level, plumb, and true.
 - 1. Fit exposed connections accurately together. Weld connections that are not to be left as exposed joints but cannot be shop welded. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.
 - 2. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.
 - 3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- B. Installing Miscellaneous Framing and Supports: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- C. Set bearing and leveling plates on cleaned surfaces using wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts and pack solidly with nonshrink, nonmetallic grout.
- D. Touch up surfaces and finishes after erection.
 - 1. Painted Surfaces: Clean field welds, bolted connections, and abraded areas and touch up paint with the same material as used for shop painting.
 - 2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 5000

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SECTION 06 1000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Rooftop equipment bases and support curbs.
 2. Wood blocking , cants, and nailers.
 3. Wood furring and grounds.
 4. Plywood backing panels.

1.2 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.
1. Include data for wood-preservative and fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee Board of Review.
- C. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
1. Wood-preservative-treated wood.
 2. Fire-retardant-treated wood.
 3. Power-driven fasteners.
 4. Powder-actuated fasteners.
 5. Expansion anchors.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. 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. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPAC2.
 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.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Comply with performance requirements in AWPAC27 (plywood).
 1. Use Interior Type A, unless otherwise indicated.
- B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Application: Treat items indicated on Drawings, and the following:
 1. Concealed blocking.
 2. Roof construction.
 3. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Blocking.
 2. Nailers.
 3. Rooftop equipment bases and support curbs.
 4. Cants.
 5. Furring.
 6. Grounds.

- B. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber with 19 percent maximum moisture content of any species.
- C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
 - 1. Mixed southern pine, No. 3 grade; SPIB.
 - 2. Eastern softwoods, No. 3 Common grade; NeLMA.
 - 3. Northern species, No. 3 Common grade; NLGA.
 - 4. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.

2.5 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified.
 - 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. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 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 for Interior Applications: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material for Exterior Applications: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.7 MISCELLANEOUS MATERIALS

- A. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION

- 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. 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.
- C. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- D. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- E. 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.

3.2 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.

END OF SECTION 06 1000

SECTION 06 4116 - PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-faced cubbies.

B. Related Requirements:

1. Section 06 1000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For plastic-laminate-faced architectural cabinets.

1. Include plans, elevations, sections, and attachment details.

C. Samples for Verification: For the following:

1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
 - a. Provide one sample applied to core material with specified edge material applied to one edge.

1.3 QUALITY ASSURANCE

- A. 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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

- B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of cabinets indicated for construction, finishes, installation, and other requirements.
- B. Grade: Custom.
- C. Type of Construction: Frameless.
- D. Door and Drawer-Front Style: Flush overlay.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
- F. Laminate Cladding for Exposed Surfaces:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Vertical Surfaces: Grade VGS.
 - 3. Other Edges: Grade VGS.
- G. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- H. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Plastic Laminate: As indicated by laminate manufacturer's designations on Drawings.
 - 2. PVC Edgebanding: As indicated by edgebanding manufacturer's designations on Drawings.

2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content: 5 to 10 percent.

- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Particleboard: ANSI A208.1, Grade M-3i.

2.3 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.
- B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch- thick metal, and as follows:
1. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.
- C. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.
- D. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.
- E. Adjustable Shelf Standards and Supports: [ANSI/BHMA A156.9, B04071; with shelf rests, B04081] [ANSI/BHMA A156.9, B04102; with shelf brackets, B04112].
- F. Shelf Rests: ANSI/BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip.
- G. Drawer Slides: ANSI/BHMA A156.9.
1. Grade 1 and Grade 2: Side mounted.
- H. Door and Drawer Locks: Provide on indicated doors and drawers.
1. Door Locks: BHMA A156.11, E07121.
 2. Drawer Locks: BHMA A156.11, E07041.
 3. Key all doors and drawers within a room alike and each room differently.
- I. Coat Hooks: Double coat hook with satin nickel finish as follows:
1. Product: Subject to compliance with requirements, provide one of the following:
 - a. Amerock; Double Prong Individual Hook.
 - b. E.H. Tate & Company; Double Robe Hook, 1866801.
 - c. Liberty Hardware; B46115J-SN-C.
- J. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for ANSI/BHMA finish number indicated.
1. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.
 2. Satin Stainless Steel: ANSI/BHMA 630.
- K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

- A. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- B. Adhesive for Bonding Plastic Laminate: Contact cement.
 - 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.
 - 2. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.5 FABRICATION

- A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.
- B. Grade: Install cabinets to comply with quality standard grade of item to be installed.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - a. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with fasteners appropriate for substrate.

END OF SECTION 06 4116

SECTION 06 4600 - WOOD TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior trim at steel joists chords.
2. Interior trim at corridor tack board displays
3. Shop finishing of wood trim.

B. Related Requirements:

1. Section 06 1000 "Rough Carpentry" for wood furring, blocking, and shims required for installing wood trim and concealed within other construction before wood trim installation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product including, finishing materials and processes.

1. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant the treated materials comply with requirements.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

C. Samples for Verification: Shop-applied transparent finishes: Not less than 5 inches wide by 12" long, for each species and cut, finished on one side and one edge.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of product.

B. Evaluation Reports: For fire-retardant-treated wood materials, from ICC-ES.

1.4 QUALITY ASSURANCE

A. 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.

B. Installer Qualifications: Fabricator of products.

1.5 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that wood trim can be supported and installed as indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver interior trim until finish operations that might damage woodwork have been completed in installation areas. Store trim in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.7 FIELD CONDITIONS

- A. Environmental Limitations for Interior Work: Do not deliver or install interior wood trim until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where interior trim is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 WOOD TRIM, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of wood trim indicated for construction, finishes, installation, and other requirements.

2.2 INTERIOR TRIM FOR TRANSPARENT FINISH

- A. Grade: Custom in accordance with AWI.
- B. Wood Species and Cut:
 - 1. Species: White oak.
 - 2. Cut: Rift cut/rift sawn.

2.3 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of wood trim and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content for Interior Materials: 5 to 10 percent.

2.4 FIRE_RETARDANT_TREATED WOOD MATERIALS

- A. Fire-Retardant-Treated Wood Materials: Where indicated, use materials complying with requirements 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.
1. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify treated materials with appropriate classification marking of qualified testing agency in form of removable paper label or imprint on surface that will be concealed from view after installation.

2.5 MISCELLANEOUS MATERIALS

- A. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.

2.6 FABRICATION

- A. Fabricate wood trim to dimensions, profiles, and details indicated. Ease edges to radius 1/16 inch (1.5 mm) unless otherwise indicated for edges of Solid-Wood (Lumber) Members.
- B. Backout or groove backs of flat trim members and kerf backs of other wide, flat members except for members with ends exposed in finished work.

2.7 SHOP FINISHING

- A. General: Finish wood trim at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing wood trim, as applicable to each unit of work.
1. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
 2. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of wood trim. Apply two coats to end-grain surfaces.
- C. Transparent Finish for Interior Trim:
1. Grade: Premium.
 2. Finish: System - 11, catalyzed polyurethane.
 3. Staining: Match Architect's sample.
 4. Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
 5. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition wood trim to average prevailing humidity conditions in installation areas.

3.2 INSTALLATION

- A. Install wood trim level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- B. Scribe and cut wood trim to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- C. Anchor wood trim to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
 - 1. For shop-finished items, use filler matching finish of items being installed.
- D. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches long except where shorter single-length pieces are necessary. Install trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).
- E. Touch up finishing work specified in this Section after installation of wood trim. Fill nail holes with matching filler where exposed.
 - 1. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are applied in shop.

END OF SECTION 06 4600

SECTION 07 2100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber blanket insulation.

B. Related Requirements:

1. Section 07 5113 "Built-up Asphalt Roofing" for insulation specified as part of roofing construction.

1.2 ACTION SUBMITTALS

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

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 INSULATING MATERIALS

- A. General: Provide insulating materials that comply with requirements and with referenced standards and, for preformed units, in sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.

1. Fungi Resistance: All insulation shall pass ASTM C 1338.

2.2 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

- A. Extruded Polystyrene Board Insulation: Maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, when tested in accordance with ASTM E 84.

1. Types and minimum compressive strengths per ASTM C 578 as follows:

- a. All Locations Unless Indicated Otherwise: Type X, 15-psi.
- b. Foundation: Type IV, 25-psi.
- c. Under Slabs Subject to Foot Traffic: Type VI, 40-psi.
- d. Under Slabs Subject to Vehicle Traffic: Type VII, 60-psi.

- e. Type V, 100-psi.
- 2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- 3. Thermal Resistivity: 5.0 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.3 GLASS-FIBER BLANKET INSULATION

- A. Glass-Fiber Blanket Insulation, Unfaced : ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, when tested in accordance with ASTM E 84; passing ASTM E 136 for combustion characteristics.
- B. Thickness: As follows unless indicated otherwise:
 - 1. Walls: 3-1/2 inches.

2.4 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - a. Product: Subject to compliance with requirements, provide Dow Chemical Company (The); Great Stuff Pro.
- B. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.
- C.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- 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. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.2 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.3 PROTECTION

- A. Protect installed insulation 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 2100

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SECTION 07 5113 - BUILT-UP ASPHALT ROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes patching existing built-up asphalt roofing systems at new penetrations.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for wood nailers, cants, curbs, and blocking.
 - 2. Division 07 Section "Sheet Metal Flashing and Trim."

1.2 PERFORMANCE REQUIREMENTS

- A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

1.3 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
- C. Samples: For each product included in roofing system.
- D. Research/evaluation reports.
- E. Maintenance data.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain components for roofing system from or approved by roofing system manufacturer.
- B. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.

1.5 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, and directions for storage.
- 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.

1.6 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.

1.7 WARRANTY

- A. Existing Warranty: Maintain Owner's existing warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Roofing Materials and Related Items: Match existing.

PART 3 - EXECUTION

3.1 INSTALLERS

- A. Installer: All patching of existing roofing shall be by one of the following:
 - 1. Hoekstra Roofing Company.

3.2 INSTALLATION

- A. General: Patch existing roof membrane in accordance with manufacturer's written instructions and recommendations, and NRCA recommendations.

3.3 FLASHING AND STRIPPING INSTALLATION

- A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to NRCA recommended details.
- B. Extend base flashing up walls or parapets a minimum of 8 inches above roofing membrane and 4 inches onto field of roofing membrane.
- C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.
- D. Install stripping, according to roofing system manufacturer's written instructions, where metal flanges and edgings are set on built-up roofing.

END OF SECTION 07 5113

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SECTION 07 6200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured reglets.

1.2 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Distinguish between shop- and field-assembled work.
3. Include identification of finish for each item.
4. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.

C. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.8 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.

1. As-Milled Finish: One-side bright mill.
2. Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.
3. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil.
4. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.
 2. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- H. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

2.5 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 5. Torch cutting of sheet metal flashing and trim is not permitted.
 6. Do not use graphite pencils to mark metal surfaces.

- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
 - 1. Coat concealed side of uncoated-aluminum sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction. Prepare joints and apply sealants to comply with requirements in Section 07 9200 "Joint Sealants."
- G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

2.6 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

2.7 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean off excess sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION 07 6200

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SECTION 07 7200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Equipment supports.
3. Preformed flashing sleeves.

B. Related Sections:

1. Section 07 6200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

B. Shop Drawings: For roof accessories.

C. Delegated-Design Submittal: For roof curbs and equipment supports 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. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design roof curbs and equipment supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Wind-Restraint Performance: As indicated on Drawings.

2.2 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
 - 1. Finish: Two-coat fluoropolymer.
 - 2. Color: As selected by Architect from manufacturer's full range.
- D. Construction:
 - 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
 - 3. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
 - 4. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
 - 5. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation.
 - 6. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 - 7. Nailer: Factory-installed wood nailer under top flange on side of curb, continuous around curb perimeter.
 - 8. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
 - 9. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 - 10. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
 - 11. Damper Tray: Provide damper tray or shelf with opening 3 inches.

2.3 EQUIPMENT SUPPORTS

- A. Equipment Supports: Rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on

Drawings, spanning between structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed structure-mounting flange at bottom.

- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
 - 1. Finish: Two-coat fluoropolymer.
 - 2. Color: As selected by Architect from manufacturer's full range.
- D. Construction:
 - 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
 - 3. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
 - 4. Nailer: Factory-installed continuous wood nailers 3-1/2 inches wide [on top flange of equipment supports] [under top flange on side of curb], continuous around support perimeter.
 - 5. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
 - 6. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 - 7. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
 - 8. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 - 9. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
 - 10. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

2.4 PIPE PORTALS

- A. Curb-Mounted Pipe Portal: Insulated roof-curb units with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom; with weathertight curb cover with single or multiple collared openings and pressure-sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless-steel snaplock swivel clamps.
- B. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless-steel snaplock swivel clamps.

2.5 PREFORMED FLASHING SLEEVES

- A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and perforated metal collar.
 - 1. Metal: Aluminum sheet, 0.063 inch thick.
 - 2. Diameter: As required for penetration..
 - 3. Finish: Manufacturer's standard.
- B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
 - 1. Metal: Aluminum sheet, 0.063 inch thick.
 - 2. Height: 13 inches.
 - 3. Diameter: As required for penetration. .
 - 4. Finish: Manufacturer's standard.

2.6 METAL MATERIALS

- A. Aluminum Sheet: ASTM B 209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
 - 1. Mill Finish: As manufactured.
- B. Steel Tube: ASTM A 500/A 500M, round tube.
- C. Galvanized-Steel Tube: ASTM A 500/A 500M, round tube, hot-dip galvanized according to ASTM A 123/A 123M.
- D. Steel Pipe: ASTM A 53/A 53M, galvanized.

2.7 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, thickness and thermal resistivity as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, and complying with AWPA C2; not less than 1-1/2 inches thick.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
- F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

- G. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- H. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

3.2 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.
- B. Clean exposed surfaces according to manufacturer's written instructions.
- C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 7200

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SECTION 07 8413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes penetration firestopping for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Provide penetration firestopping with the following ratings determined per ASTM E 814 or UL 1479:
 - 1. F-Rated Systems: Provide penetration firestopping with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. T-Rated Systems: For the following conditions, provide penetration firestopping with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
 - a. Penetrations located outside wall cavities.
 - b. Penetrations located outside fire-resistance-rated shaft enclosures.
- C. For penetration firestopping exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 3. For penetrations involving insulated piping, provide penetration firestopping not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS

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

- B. Shop Drawings: For each penetration firestopping system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each penetration firestopping system configuration for construction and penetrating items.
 - 2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- C. Penetration Firestopping Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
 - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
- D. Qualification Data: For Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Provide penetration firestopping that complies with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 - 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 - 2. Penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems bearing classification marking of qualified testing and inspecting agency.
- C. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- D. Do not cover up penetration firestopping installations that will become concealed behind other construction until each installation has been examined by building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 FIRESTOPPING

- A. Compatibility: Provide penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating firestop systems, under conditions of service and application, as demonstrated by penetration firestop system manufacturer based on testing and field experience.
- B. Accessories: Provide components for each penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Collars.
 - 5. Steel sleeves.

2.2 MIXING

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install penetration firestop systems, to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
- D. Labeling of Protective Construction: In accessible areas above ceilings or in attics, identify all walls that require penetrations be firestopped with signs or stenciling reading "Fire and/or smoke barrier. Protect all openings." Letters shall be minimum 1/2 inch high.
 1. Place signs or stenciling at 30 ft. on center maximum.

3.2 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION 07 8413

SECTION 07 9200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
 - 1. Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 2. Interior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 3. Interior joints in horizontal traffic surfaces.
- B. Related Sections include the following:
 - 1. Division 08 Section "Glazing" for glazing sealants.
 - 2. Division 09 Section "Gypsum Board" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.4 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- C. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- D. Multicomponent Nonsag Neutral-Curing Silicone Sealant ES-1:
 - 1. Products:
 - a. Dow Corning Corporation; 756 H.P.
 - b. Tremco; Spectrem 4-TS.
 - 2. Type and Grade: M (multicomponent) and NS (nonsag).
 - 3. Class: 50.
 - 4. Use Related to Exposure: NT (nontraffic).
 - 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
- E. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant ES-2:
 - 1. Products:
 - a. Pecora Corporation; 898.
 - b. Tremco; Tremsil 600 White.
 - 2. Type and Grade: S (single component) and NS (nonsag).
 - 3. Class: 25.

4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

F. Single-Component Mildew-Resistant Acid-Curing Silicone Sealant ES-3:

1. Products:
 - a. Dow Corning Corporation; 786 Mildew Resistant.
 - b. GE Silicones; Sanitary SCS1700.
 - c. Tremco; Tremsil 200 Clear.
2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 25.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.

G. Multicomponent Nonsag Urethane Sealant ES-4:

1. Products:
 - a. Pacific Polymers, Inc.; Elasto-Thane 227 Type II (Gun Grade).
 - b. Pecora Corporation; Dynatred.
 - c. Polymeric Systems Inc.; PSI-270.
 - d. Tremco; Dymeric 240FC
2. Type and Grade: M (multicomponent) and NS (nonsag).
3. Class: 25.
4. Use Related to Exposure: T (traffic) and NT (non-traffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

H. Multicomponent Pourable Urethane Sealant ES-5:

1. Products:
 - a. Bostik Findley; Chem-Calk 550.
 - b. Pecora Corporation; Urexpan NR-200.
 - c. Tremco; THC-900.
2. Type and Grade: M (multicomponent) and P (pourable).
3. Class: 25.
4. Use Related to Exposure: T (traffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

2.4 SOLVENT-RELEASE JOINT SEALANTS

A. Butyl-Rubber-Based Solvent-Release Joint Sealant SRS-1: Comply with ASTM C 1085.

1. Products:
 - a. Bostik Findley; Bostik 300.
 - b. Pecora Corporation; BC-158.

- c. Polymeric Systems Inc.; PSI-301.
- d. Sonneborn, Division of ChemRex Inc.; Sonneborn Multi-Purpose Sealant.
- e. Tremco; Tremco Butyl Sealant.

- B. Pigmented Narrow-Joint Sealant SRS-2: Manufacturer's standard, solvent-release-curing, pigmented, synthetic-rubber sealant complying with AAMA 803.3 and formulated for sealing joints 3/16 inch or smaller in width.

1. Products:

- a. Fuller, H. B. Company; SC-0289.
- b. Schnee-Morehead, Inc.; SM 5504 Acryl-R Narrow Joint Sealant.

2.5 LATEX JOINT SEALANTS

- A. Latex Sealant: Comply with ASTM C 834, Type OP, Grade NF.

1. Products:

- a. Bostik Findley; Chem-Calk 600.
- b. Pecora Corporation; AC-20+.
- c. Schnee-Morehead, Inc.; SM 8200.
- d. Sonneborn, Division of ChemRex Inc.; Sonolac.
- e. Tremco; Tremflex 834.

2.6 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 that 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:

- a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
- b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

2.7 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down

to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.

- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants.
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant.
 - a. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 - 2. Remove laitance and form-release agents from concrete.
 - a. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates, 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.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION

- A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- B. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
- G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.3 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application JS-1: Exterior vertical joints between dissimilar materials.
 - 1. Joint Sealant: Multicomponent nonsag neutral-curing silicone sealant ES-1.
- B. Joint-Sealant Application JS-2: Exterior perimeter joints between exterior wall construction and frames of doors.
 - 1. Joint Sealant: Multicomponent nonsag neutral-curing silicone sealant ES-1.

- C. Joint-Sealant Application JS-3: Interior perimeter joints of exterior openings.
 - 1. Joint Sealant: Multicomponent nonsag neutral-curing silicone sealant ES-1.
- D. Joint-Sealant Application JS-4: Interior ceramic tile expansion, control, contraction, and isolation joints in horizontal traffic surfaces.
 - 1. Joint Sealant: Multicomponent pourable urethane sealant ES-5.
- E. Joint-Sealant Application JS-5: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
 - 1. Joint Sealant: Single-component mildew-resistant neutral-curing silicone sealant ES-2.
 - 2. Joint-Sealant Color: White.
- F. Joint-Sealant Application JS-6: Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
 - 1. Joint Sealant: Latex sealant.
- G. Joint-Sealant Application JS-7: Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
 - 1. Joint Sealant: Latex sealant.
- H. Joint-Sealant Application JS-8: Interior control, expansion, and isolation joints in vertical and horizontal non-traffic surfaces of ceramic tile.
 - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-4.
- I. Joint-Sealant Application JS-9: Interior joints between backsplashes and countertops, and corners in backsplashes.
 - 1. Joint Sealant: Single-component mildew-resistant acid-curing silicone sealant ES-3.
 - 2. Color: Clear.

END OF SECTION 07 9200

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SECTION 08 1113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes standard hollow metal frames.
 - 1. Standard hollow metal frames.
- B. Related Sections:
 - 1. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
 - 2. Division 09 Section "Interior Painting" for field painting hollow metal doors and frames.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.
- E. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- C. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 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 257 or UL 9. Label each individual glazed lite.
- D. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to finish of factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amweld Building Products, LLC.
 - 2. Ceco Door Products; an Assa Abloy Group company.
 - 3. Curries Company; an Assa Abloy Group company.
 - 4. Steelcraft; an Ingersoll-Rand company.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, CS, Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, CS, Type B.
- C. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
- F. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- G. Glazing: Division 08 Section "Glazing."

- H. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8.
- B. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
 - 1. Fabricate frames as face welded unless otherwise indicated.
 - 2. Frames for Level 2 Steel Doors: 0.053-inch- thick steel sheet.
 - 3. Frames for Wood Doors: 0.053-inch- thick steel sheet.
 - 4. Frames for Borrowed Lights: 0.053-inch- thick steel sheet.
- C. Hardware Reinforcement: ANSI/SDI A250.6.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 - 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
 - 3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 - 2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.5 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, same material as door face sheet.
- B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, same material as frames.

2.6 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

- B. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.7 FABRICATION

- A. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- B. Hollow Metal Frames: Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 2. Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 6. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
 - b. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
- C. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26, 27, and 28 electrical Sections.
- D. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow metal work.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.8 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
1. Shop Primer: ANSI/SDI A250.10.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hollow Metal Frames: Comply with ANSI/SDI A250.11.
1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable glazing stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 4. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

5. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
 6. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- B. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.2 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- C. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08 1113

SECTION 08 1416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Solid-core doors with thermally-fused laminate faces.

1.2 SUBMITTALS

- A. Product Data: For each type of door indicated. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate requirements for veneer matching.
 - 4. Indicate doors to be factory finished and finish requirements.
 - 5. Indicate fire-protection ratings for fire-rated doors.
- C. Samples for Verification:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three samples showing typical range of color and grain to be expected in the finished work.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors from single manufacturer.
- B. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated."
- C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Base-Bid:
 2. Basis of Design (match existing)
 - a. Maiman
 - 1) Harvest Maple 7953
 - b. Marshfield Door Systems, Inc.
 - c. Algoma Hardwoods, Inc.
 - d. Baillargeon.Marshfield Door Systems, Inc.
 - e. Oshkosh Architectural Door Company.
 - f. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

- A. Particleboard-Core Doors:
1. Particleboard: ANSI A208.1, Grade LD-2.
 2. Doors with Closers, Automatic Operators, or Exit Devices: Provide doors with either glued-wood-stave or structural-composite-lumber cores instead of particleboard cores; or doors with blocking as follows:
 - a. 5-inch top-rail blocking, in doors indicated to have closers.

- b. 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - c. 5-inch midrail blocking, in doors indicated to have exit devices.
- B. Structural-Composite-Lumber-Core Doors:
 - 1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf.
 - b. Screw Withdrawal, Edge: 400 lbf.
- C. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 - 1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
- D. Mineral-Core Doors:
 - 1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
 - 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as follows:
 - a. 5-inch top-rail blocking.
 - b. 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - c. 5-inch midrail blocking, in doors indicated to have armor plates.
 - d. 5-inch midrail blocking, in doors indicated to have exit devices.
 - 3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 THERMALLY-FUSED LAMINATE-FACED DOORS

- A. Interior Solid-Core Doors:
 - 1. Grade: Premium.
 - 2. Plastic-Laminate Faces: Low-pressure decorative laminates faces thermally fused to cores under heat and pressure, complying with Laminating Materials Association's Product Standard and Typical Physical Properties of Decorative Overlays. LMA.2003.
 - 3. Colors, Patterns, and Finishes: As selected by Architect from door manufacturer's full range of products.
 - 4. Exposed Vertical Edges: Impact-resistant polymer edging, minimum 0.040 inch thick, applied to all four edges after faces; color or wood grain pattern shall be the same as the faces.
 - 5. Core: Particleboard.
 - 6. Construction: Three plies. Stiles and rails are bonded to core, then entire unit abrasive planed before faces are applied. Faces are bonded to core using a hot press.

2.4 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 1. Comply with requirements in NFPA 80 for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, and DHI A115-W series standards. Machine doors in accordance with hardware manufacturer's templates.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- C. Openings: Cut and trim openings through doors in factory.
 - 1. Glazing: Factory install glazing. Comply with applicable requirements in Division 08 Section "Glazing."

2.5 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Finish doors at factory.
- C. Finish doors at factory [that are indicated to receive transparent finish. Field finish doors indicated to receive opaque finish] [where indicated in schedules or on Drawings as factory finished].
- D. Transparent Finish:
 - 1. Grade: Premium.
 - 2. Finish: AWI catalyzed polyurethane system.
 - 3. Finish: AWI [conversion varnish] [or] [catalyzed polyurethane] <Insert finish designation> system.
 - 4. Staining: As selected from manufacture's full range.
 - 5. Effect: Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores.
 - 6. Sheen: Satin.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hardware: For installation, see Division 08 Section "Door Hardware."

- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.

- 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

3.2 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 1416

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SECTION 08 4113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Spandrel glazing for exterior storefront openings.
- B. Related Sections:
 - 1. Division 08 Section "Glazing".

1.2 ALTERNATES

- A. The Work of this Section is affected by alternates. Refer to Section 01 2300 "Alternates" for procedures for alternates.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
 - 1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - 2. Dimensional tolerances of building frame and other adjacent construction.
 - 3. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferring to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Noise or vibration created by wind and by thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.
 - f. Failure of operating units.
- B. Wind Loads: 20.00 lbf/sq. ft..
- C. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
 - 1. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 - 2. Test Durations: 10 seconds.

- D. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft..
- E. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 8.00 lbf/sq. ft..
- F. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. 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.
- G. Condensation Resistance: Provide aluminum-framed systems with framing areas having condensation-resistance factor (CRF) of not less than 60 when tested according to AAMA 1503.
- H. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.45 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
- C. Delegated-Design Submittal: For aluminum-framed systems 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. Detail fabrication and assembly of aluminum-framed systems.
 - 2. Include design calculations.
- D. Qualification Data: For qualified Installer.
- E. Maintenance data.
- F. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

- B. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
- D. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
- E. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.
 - 1. Obtain aluminum doors and frames from a single source. Verify that doors and frames will operate and seal properly with specified hardware.
- F. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, structural failures, excessive deflection, noise or vibration caused by thermal movements, deterioration of metals and metal finishes and beyond normal weathering, failure of operating components and water leakage through fixed glazing and framing areas.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - 1. Storefront Framing:
 - a. EFCO Corporation.

- b. Kawneer North America; an Alcoa company.
- c. Tubelite.
- d. United States Aluminum.
- e. Vistawall Architectural Products; The Vistawall Group; a Bluescope Steel company.
- f. YKK AP America Inc.

2.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B 209.
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 - 4. Structural Profiles: ASTM B 308/B 308M.
 - 5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
 - 1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.
- D. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
 - 1. Overall Panel Thickness: 1 inch.
 - 2. Exterior Skin: Aluminum.
 - a. Thickness: Manufacturer's standard for finish and texture indicated.
 - b. Finish: High-performance organic finish.
 - 1) Color as selected from manufacturer's full range, including "premium" colors.
 - c. Texture: Smooth.
 - 3. Interior Skin: Aluminum.
 - a. Thickness: Manufacturer's standard for finish and texture indicated.

- b. Finish: High-performance organic finish.
 - 1) Color as selected from manufacturer's full range, including "premium" colors.
- c. Texture: Smooth.
- 4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
- 5. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 or less.

2.4 ACCESSORY MATERIALS

- A. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.5 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from exterior.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 08 Section "Glazing."

G. Erection Tolerances: Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.
2. Alignment:
 - a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.
3. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

END OF SECTION 08 4113

SECTION 08 7100 – 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. Electromechanical door hardware.
 - 3. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Door Hardware Schedule".
 - 2. Division 08 Section "Hollow Metal Doors and Frames".
 - 3. Division 08 Section "Flush Wood Doors".
 - 4. Division 08 Section "Access Control Hardware".
- 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 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. Michigan Building Code 2012, 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.
 - h. Warranty information for each product.
 - 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. Shop Drawings: Details of electrified access control hardware indicating the following:
 - 1. 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:
 - a. 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.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 - 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified installer of Windstorm assemblies.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

F. 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.

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: A minimum 3 years documented experience installing both standard and electrified door 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 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.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source 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. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. **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. This meeting is mandatory.**

1. 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. This meeting is mandatory.

2. Coordination of Trades Meeting for openings with electromechanical hardware to be facilitated by the Construction Manager.
 - a. Review sequence of operation narratives for each unique access controlled opening.
 - b. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - c. Review and finalize construction schedule and verify availability of materials.
 - d. Review the required inspecting, testing, commissioning, and demonstration procedures.

- G. **Post-installation Conference: After installation of door hardware, conduct a project specific training meeting to examine the installing contractors' personnel installation and adjustment of their respective products. Post-installation conference to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. This meeting is mandatory.**
- H. 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 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.
- C. Door and Frame Preparation: 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 closer bodies.
 - 4. Two years for electromechanical door hardware.

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.

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.
- B. 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:
- C. 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.

- D. 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. Quantity: Provide the following hinge quantity, unless otherwise indicated:
 2. 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:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinges for 180 degree openings: Provide wide throw hinges as required to make sure door can swing 180 degrees.
 5. 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 all out-swinging lockable doors.
 6. Acceptable Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products (MK).
 - c. Ives (IV).

2.3 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
1. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor.
 2. Furnish dust proof strikes for bottom bolts.
 3. 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.
 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Acceptable Manufacturers:
 - a. Ives
 - b. Rockwood Manufacturing (RO).
 - c. Trimco (TC).

2.4 CYLINDERS AND KEYING

- A. Cylinders: Existing 7-Pin small format interchangeable core (SFIC) Best key system.
 1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
 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. Provide all cylinder housings with disposable construction core.
 5. Owner (KPS) provides final cores.
 6. Acceptable manufacturers:
 - a. Stanley Best (BE).
 - b. Marshall Best Systems (MB).

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
 1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. Sargent Manufacturing (SA) – 8200 Series.
 - c. Schlage (SC) – L9000 Series.
 - d. Stanley Best (BE) – 40H Series.

2.6 STAND ALONE ACCESS CONTROL LOCKING DEVICES

- A. Stand Alone Locksets: ANSI A156.2, Series 4000, Grade 1 locking mechanism complete with integrated touchscreen or keypad as specified for access and programming. Voice-guided programming with 12-digit PIN code selection and up to 1000 user option. Locks to accept standard, small format interchangeable core, security and patented cylinders. Battery-operated, with low power indicator, or hard-wired (9 Volt external power supply) option.
 1. Manufacturers:
 - a. ASSA ABLOY ACCENTRA, formerly known as Yale (YA) - nexTouch Series.

2.7 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, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
- B. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Auxiliary Deadlocks: BHMA A156.5.
 - 3. Dustproof Strikes: BHMA A156.16.

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 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 - 3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
 - 4. 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.
 - 5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 - 6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 - 7. All regular mount (pull side mount) and parallel arm mount closers shall have thru-bolt fasteners for mounting.
 - 8. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and thru-bolt and security type fasteners as required for proper installation.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): 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 body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Acceptable Manufacturers:
 - a. Norton Door Controls (NO) – 7500 Series.
 - b. LCN Closers (LC) - 4040XP Series.
 - c. NOTE: Install all closers on Wood Doors with thru-bolts. Do not thru-bolt exterior aluminum doors.

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. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inchthick.
4. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
5. Acceptable Manufacturers:
 - a. Rockwood Manufacturing (RO).

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. Rockwood Manufacturing (RO).
 - b. Trimco (TC).
 - c. Ives

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. 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.
- C. 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.
 - 1. 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.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Acceptable Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Manufacturing (PE).
 - 3. Reese Enterprises, Inc. (RS).

2.12 ELECTRONIC ACCESSORIES

- A. Card Readers, Power Supplies, Door Contacts and Request to Exit provided by Security Contractor.

2.13 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.

2.14 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. 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.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RO - Rockwood
4. RU - Corbin Russwin
5. BE - dormakaba Best
6. AC - Accentra
7. NO - Norton

Hardware Sets

Set: 1.0

Doors: D225B, D225G

3 Hinge (heavy weight)	T4A3786 4-1/2"	US26D	MK
1 Access Control Mort Lock	AUR NTM620-NR Less Cylinder	626	AC
1 Mortise Cylinder	1E-74 Less Core	626	BE
1 Core	Provided by KPS	626	BE
1 Surface Closer	7500 TBGN (RA)	689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Gasketing	S88BL		PE

1 Wall Stop	406	US32D	RO
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Notes: Standalone battery-operated keypad lock. Access by valid pin number on keypad. Key override.

Set: 2.0

Doors: D225E

3 Hinge (heavy weight)	T4A3786 4-1/2"	US26D	MK
1 Access Control Mort Lock	AUR NTM620-NR Less Cylinder	626	AC
1 Mortise Cylinder	1E-74 Less Core	626	BE
1 Core	Provided by KPS	626	BE
1 Surface Closer	CPS7500 TBGN	689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Gasketing	S88BL		PE
1 Wall Stop	406	US32D	RO

Notes: Standalone battery-operated keypad lock. Access by valid pin number on keypad. Key override.

Set: 3.0

Doors: D225F

3 Hinge, Full Mortise	TA2714	US26D	MK
1 Office Lock	ML2053 NSA M34 LC	626	RU
1 Mortise Cylinder	1E-74 Less Core	626	BE
1 Core	Provided by KPS	626	BE
1 Surface Closer	CPS7500 TBGN	689	NO
1 Wall Stop	406	US32D	RO

Set: 4.0

Doors: D225D, D225C

3 Hinge (heavy weight)	T4A3786 5"	US26D	MK
1 Passage Set	ML2010 NSA	626	RU
1 Wall Stop	487	US26D	RO
3 Silencer	608 / 609		RO

Set: 5.0

Doors: D225A

3 Hinge, Full Mortise	TA2714	US26D	MK
1 Privacy Lock	ML2060 NSA M34 V21	626	RU

**PROJECT NO. 23-612.00
KPS LOY NORRIX HIGH SCHOOL HEALTH SUITE
KALAMAZOO PUBLIC SCHOOLS**

**DOOR HARDWARE
08 7100 - 15
ADD #1 - 03-28-2024**

1 Surface Closer	7500 TBGN - pull side mount	689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Wall Stop	406 / 409	US32D	RO
1 Gasketing	S88BL		PE
1 Coat Hook	796	US26D	RO

END OF SECTION 08 7100

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SECTION 08 7100 – 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. Electromechanical door hardware.
 - 3. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Door Hardware Schedule".
 - 2. Division 08 Section "Hollow Metal Doors and Frames".
 - 3. Division 08 Section "Flush Wood Doors".
 - 4. Division 08 Section "Access Control Hardware".
- 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 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. Michigan Building Code 2012, 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.
 - h. Warranty information for each product.
 - 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. Shop Drawings: Details of electrified access control hardware indicating the following:
 - 1. 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:
 - a. 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.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 - 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified installer of Windstorm assemblies.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

F. 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.

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: A minimum 3 years documented experience installing both standard and electrified door 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 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.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source 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. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. **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. This meeting is mandatory.**

1. 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. This meeting is mandatory.

2. Coordination of Trades Meeting for openings with electromechanical hardware to be facilitated by the Construction Manager.
 - a. Review sequence of operation narratives for each unique access controlled opening.
 - b. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - c. Review and finalize construction schedule and verify availability of materials.
 - d. Review the required inspecting, testing, commissioning, and demonstration procedures.

- G. **Post-installation Conference: After installation of door hardware, conduct a project specific training meeting to examine the installing contractors' personnel installation and adjustment of their respective products. Post-installation conference to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. This meeting is mandatory.**
- H. 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 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.
- C. Door and Frame Preparation: 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 closer bodies.
 - 4. Two years for electromechanical door hardware.

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.

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.
- B. 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:
- C. 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.

- D. 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. Quantity: Provide the following hinge quantity, unless otherwise indicated:
 2. 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:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinges for 180 degree openings: Provide wide throw hinges as required to make sure door can swing 180 degrees.
 5. 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 all out-swinging lockable doors.
 6. Acceptable Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products (MK).
 - c. Ives (IV).

2.3 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
1. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor.
 2. Furnish dust proof strikes for bottom bolts.
 3. 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.
 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Acceptable Manufacturers:

- a. Ives
- b. Rockwood Manufacturing (RO).
- c. Trimco (TC).

2.4 CYLINDERS AND KEYING

A. Cylinders: Existing 7-Pin small format interchangeable core (SFIC) Best key system.

- 1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
- 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. Provide all cylinder housings with disposable construction core.
- 5. Owner (KPS) provides final cores.
- 6. Acceptable manufacturers:
 - a. Stanley Best (BE).
 - b. Marshall Best Systems (MB).

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

- 1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. Sargent Manufacturing (SA) – 8200 Series.
 - c. Schlage (SC) – L9000 Series.
 - d. Stanley Best (BE) – 40H Series.

2.6 STAND ALONE ACCESS CONTROL LOCKING DEVICES

A. Stand Alone Locksets: ANSI A156.2, Series 4000, Grade 1 locking mechanism complete with integrated touchscreen or keypad as specified for access and programming. Voice-guided programming with 12-digit PIN code selection and up to 1000 user option. Locks to accept standard, small format interchangeable core, security and patented cylinders. Battery-operated, with low power indicator, or hard-wired (9 Volt external power supply) option.

- 1. Manufacturers:
 - a. ASSA ABLOY ACCENTRA, formerly known as Yale (YA) - nexTouch Series.

2.7 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, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
- B. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Auxiliary Deadlocks: BHMA A156.5.
 - 3. Dustproof Strikes: BHMA A156.16.

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 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 - 3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
 - 4. 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.
 - 5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 - 6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 - 7. All regular mount (pull side mount) and parallel arm mount closers shall have thru-bolt fasteners for mounting.
 - 8. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and thru-bolt and security type fasteners as required for proper installation.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): 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 body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Acceptable Manufacturers:
 - a. Norton Door Controls (NO) – 7500 Series.
 - b. LCN Closers (LC) - 4040XP Series.
 - c. NOTE: Install all closers on Wood Doors with thru-bolts. Do not thru-bolt exterior aluminum doors.

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. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inchthick.
4. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
5. Acceptable Manufacturers:
 - a. Rockwood Manufacturing (RO).

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. Rockwood Manufacturing (RO).
 - b. Trimco (TC).
 - c. Ives

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. 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.
- C. 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.
 - 1. 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.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Acceptable Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Manufacturing (PE).
 - 3. Reese Enterprises, Inc. (RS).

2.12 ELECTRONIC ACCESSORIES

- A. Card Readers, Power Supplies, Door Contacts and Request to Exit provided by Security Contractor.

2.13 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.

2.14 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. 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.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RO - Rockwood
4. RU - Corbin Russwin
5. BE - dormakaba Best
6. AC - Accentra
7. NO - Norton

Hardware Sets

Set: 1.0

Doors: D225B, D225G

3 Hinge (heavy weight)	T4A3786 4-1/2"	US26D	MK
1 Access Control Mort Lock	AUR NTM620-NR Less Cylinder	626	AC
1 Mortise Cylinder	1E-74 Less Core	626	BE
1 Core	Provided by KPS	626	BE
1 Surface Closer	7500 TBGN (RA)	689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Gasketing	S88BL		PE

1 Wall Stop	406	US32D	RO
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Notes: Standalone battery-operated keypad lock. Access by valid pin number on keypad. Key override.

Set: 2.0

Doors: D225E

3 Hinge (heavy weight)	T4A3786 4-1/2"	US26D	MK
1 Access Control Mort Lock	AUR NTM620-NR Less Cylinder	626	AC
1 Mortise Cylinder	1E-74 Less Core	626	BE
1 Core	Provided by KPS	626	BE
1 Surface Closer	CPS7500 TBGN	689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Gasketing	S88BL		PE
1 Wall Stop	406	US32D	RO

Notes: Standalone battery-operated keypad lock. Access by valid pin number on keypad. Key override.

Set: 3.0

Doors: D225F

3 Hinge, Full Mortise	TA2714	US26D	MK
1 Office Lock	ML2053 NSA M34 LC	626	RU
1 Mortise Cylinder	1E-74 Less Core	626	BE
1 Core	Provided by KPS	626	BE
1 Surface Closer	CPS7500 TBGN	689	NO
1 Wall Stop	406	US32D	RO

Set: 4.0

Doors: D225D, D225C

3 Hinge (heavy weight)	T4A3786 5"	US26D	MK
1 Passage Set	ML2010 NSA	626	RU
1 Wall Stop	487	US26D	RO
3 Silencer	608 / 609		RO

Set: 5.0

Doors: D225A

3 Hinge, Full Mortise	TA2714	US26D	MK
1 Privacy Lock	ML2060 NSA M34 V21	626	RU

1 Surface Closer	7500 TBGN - pull side mount	689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Wall Stop	406 / 409	US32D	RO
1 Gasketing	S88BL		PE
1 Coat Hook	796	US26D	RO

END OF SECTION 08 7100

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SECTION 08 8000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Doors.
 - 2. Interior borrowed lites.
 - 3. Storefront framing.

1.2 DEFINITIONS

- A. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- B. 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.
- C. 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.
- D. 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.

1.3 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 indicated, but not less than wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads."
 - b. 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.
 - c. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 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 insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - 2. 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.

1.4 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Samples: 12-inch- square, for each type of glass product indicated, other than monolithic clear float glass.
- C. Glazing Schedule: Use same designations indicated on Drawings.
- 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.

1.5 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; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

- B. Source Limitations for Glass: Obtain insulating glass through one source from a single manufacturer for each glass type.
- 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. 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."

1.6 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to 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: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to 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 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 GLASS PRODUCTS

- A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
 - 2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 - 3. For uncoated glass, comply with requirements for Condition A.
 - 4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
 - 5. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated or required.
- C. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B (spandrel glass, one surface ceramic coated), Type I (transparent flat glass), Quality-Q3, and complying with other requirements specified.
 - 1. Fallout Resistance: Provide spandrel units identical to those passing the fallout-resistance test for spandrel glass specified in ASTM C 1048.
- D. Sputter-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified.
- E. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:
 - 1. Interlayer: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
 - a. For polyvinyl butyral interlayers, laminate lites in autoclave with heat plus pressure.
 - 2. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.
- F. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
 - 1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 - 2. Provide Kind FT (fully tempered) glass lites where safety glass is indicated or required.
 - 3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
 - 4. Sealing System: Dual seal.
 - 5. Spacer Specifications: Manufacturer's standard spacer material and construction.

6. Spacer Specifications: Manufacturer's standard spacer material and construction complying with the following requirements:
 - a. Spacer Material: Aluminum with mill or clear anodic finish.
 - b. Desiccant: Molecular sieve or silica gel, or blend of both.
 - c. Corner Construction: Manufacturer's standard corner construction.

2.3 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
 1. Neoprene, ASTM C 864.
 2. EPDM, ASTM C 864.
 3. Silicone, ASTM C 1115.
 4. Thermoplastic polyolefin rubber, ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
 1. Neoprene.
 2. EPDM.
 3. Silicone.
 4. Thermoplastic polyolefin rubber.

2.4 GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
 1. Compatibility: Select 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 manufacturers' 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. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
 1. Single-Component Neutral-Curing Silicone Glazing Sealants:
 - a. Products:
 - 1) GE Silicones; SilPruf SCS2000.
 - 2) Pecora Corporation; 890.
 - 3) Polymeric Systems Inc.; PSI-641.

4) Tremco; Spectrem 3.

- b. Type and Grade: S (single component) and NS (nonsag).
- c. Class: 50.
- d. Use Related to Exposure: NT (nontraffic).
- e. Uses Related to Glazing Substrates: M, G, A, and, as applicable to glazing substrates indicated, O.
- f. Applications: Weatherseal.

2. Neutral-Curing Silicone Glazing Sealants:

a. Products:

- 1) Dow Corning Corporation; 791.
- 2) GE Silicones; SilPruf NB SCS9000.
- 3) Pecora Corporation; 895.

- b. Type and Grade: S (single component) and NS (nonsag).
- c. Class: 50.
- d. Use Related to Exposure: NT (nontraffic).
- e. Uses Related to Glazing Substrates: M, G, A, and, as applicable to glazing substrates indicated, O.
- f. Applications: Interior wet glazing installations.

2.5 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type C (closed-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.6 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.
2. Grind smooth and polish exposed glass edges and corners.

2.7 MONOLITHIC GLASS UNITS

- A. Uncoated Clear Float-Glass Units: Class 1 (clear) annealed or Kind HS (heat-strengthened) float glass where heat strengthening is required to resist thermal stresses induced by differential shading of individual glass lites and to comply with system performance requirements, and Kind FT (fully tempered) float glass where indicated or required.

1. Thickness: 6.0 mm unless indicated otherwise.

2.8 LAMINATED-GLASS UNITS

- A. Laminated-Glass Units LG-1:

1. Kind LA, consisting of two lites of annealed float glass.
2. Outer and Inner Lites: Class 1 (clear) float glass, each lite 3 mm thick.
3. Plastic Interlayer: Clear, 0.030 inch thick.

2.9 INSULATING-GLASS UNITS

- A. Solar-Control Low-E Insulating-Glass Units IG-1:

1. Products:
 - a. AFG Industries: Comfort Ti-AC 36.
 - b. Cardinal Glass Industries: LoE-172.
 - c. Guardian Industries Corp.: NP-61.
 - d. Interpane: ILE-174.
 - e. PPG: Solarban 60.
2. Overall Unit Thickness and Thickness of Each Lite: 25 and 6.0 mm.
3. Interspace Content: Argon.
4. Outdoor Lite: Class 1 (clear) float glass.
 - a. Kind FT (fully tempered).
 - b. Self-Cleaning, Low-Maintenance Coating: Pyrolytic coating on first surface.
5. Low-E Coating: Sputtered on second surface.
6. Low-E-Coated Film: Suspended in the interspace.
7. Silk-Screened Coating: Ceramic enamel on second surface.
 - a. Color and Pattern: Match.
8. Visible Light Transmittance: 61 percent minimum.
9. Winter Nighttime U-Factor: 0.31 maximum.
10. Summer Daytime U-Factor: 0.33 maximum.
11. Solar Heat Gain Coefficient: 0.41 maximum.

- B. Ceramic-Coated Spandrel Insulating-Glass Units ISP-1/G-2:
 - 1. Construction: Provide units that comply with requirements specified for insulating-glass units designated IG-1 except for indoor lite.
 - 2. Indoor Lite: Ceramic-coated spandrel glass.
 - a. Kind FT (fully tempered).
 - b. Ceramic Coating Location: Fourth surface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep system.
 - 3. Minimum required face or edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GLAZING

- A. General: Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
 - 1. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
 - 2. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
 - 3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
 - 4. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
 - 5. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
 - 6. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 7. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- B. Gasket Glazing (Dry): Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

1. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
 2. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
 3. Install gaskets so they protrude past face of glazing stops.
- C. Sealant Glazing (Wet): Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
1. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
 2. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.3 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- B. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

3.4 GLAZING SCHEDULE

- A. Exterior Openings:
1. Solar-control low-e insulating-glass units IG-1.
 2. Spandrel Glass ISP-1:
 - a. Ceramic-coated spandrel insulating-glass glazed into IG-1.
- B. Interior Openings: Safety glass 6 mm thick unless indicated otherwise.

END OF SECTION 08 8000

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SECTION 09 2216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
3. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Evaluation reports for firestop tracks.

1.4 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.
- B. Studs, Runners, and Tracks: ASTM C 645.
 1. Minimum Base-Metal Thickness: 0.0329 inch.
 2. Steel Studs and Tracks: Depth: 3-5/8 inches (92 mm) unless indicated otherwise.
- C. Slip-Type Head Joints: Where indicated, provide one of the following:
 1. Single Long-Leg Track System: ASTM C 645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 2. Double-Track System: ASTM C 645 top outer tracks, inside track with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
 3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) BlazeFrame Industries; Bare Slotted Track (BST/BST 2).
 - 2) CEMCO; California Expanded Metal Products Co.; CST Slotted Deflection Track.
 - 3) ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
 - 4) Metal-Lite; The System.
 - 5) Steel Network, Inc. (The); VertiTrack VT.
- D. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.
 1. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- E. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BlazeFrame Industries; Intumescent Framing, Fire Stop System.
 - b. CEMCO; California Expanded Metal Products Co.; FAS Track.
 - c. ClarkDietrich Building Systems; BlazeFrame.
 - d. Fire Trak Corp; Fire Trak System attached to studs with Fire Trak Posi Klip.
 - e. Metal-Lite; The System.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 1. Minimum Base-Metal Thickness: 0.0329 inch.
 2. Depth: 7/8 inch unless indicated otherwise.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

- C. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
 - 1. Depth: 1-1/2 inches.
- E. Furring Channels (Furring Members):
 - 1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base-Metal Thickness: 0.0329 inch.
- F. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; 640/660 Drywall Ceiling Suspension.
 - c. United State Gypsum Company; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226/D 226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been

installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754 and AISI S200.
 - 1. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 - 2. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

- a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. Direct Furring: Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Do not attach hangers to steel roof deck.
 - 5. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 2216

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SECTION 09 2900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 09 2216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.2 ACTION SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
- D. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CertainTeed Corporation.
 - 2. Continental Building Products, LLC.
 - 3. Georgia-Pacific Building Products.
 - 4. National Gypsum Company.
 - 5. Temple-Inland Building Products by Georgia-Pacific.
 - 6. USG.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
- C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 - 1. Thickness: 1/2 inch.
 - 2. Long Edges: Tapered.
- D. Impact-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
 - 1. Products:
 - a. Continental Building Products, LLC; Protecta HIR 300.
 - b. National Gypsum Company; Hi-Impact XP Wallboard.
 - c. USG Corporation; Mold Tough VHI Abuse-Resistant Panels.
 - 2. Core: 5/8 inch, Type X.
 - 3. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
 - 4. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 - 5. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
 - 6. Hard-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements according to test in Annex A1.
 - 7. Long Edges: Tapered.
 - 8. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.3 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, provide one of the following:
 - a. CertainTeed Corporation; GlasRoc Tile Backer.
 - b. Georgia-Pacific Building Products; DensShield Tile Backer.
 - c. National Gypsum Company; eXP Tile Backer.
 - d. Temple-Inland Building Products by Georgia-Pacific; Green Glass Tilebacker.
 - e. USG; Durock Brand Glass-Mat Tile Backerboard.
 - 2. Core: 5/8 inch, Type X.
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (control) joint.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fry Reglet Corporation.
 - b. Gordon Inc.
 - c. Pittcon Industries.
 - 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
 - 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. 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 or beveled panel edges, and damaged surface areas, use setting-type taping compound.

2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.6 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
- C. 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.

PART 3 - EXECUTION

3.1 APPLYING PANELS

- A. General: Comply with ASTM C 840.
 1. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
 2. Form control and expansion joints with space between edges of adjoining gypsum panels.
 3. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - a. 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. in area.
 - b. Fit gypsum panels around ducts, pipes, and conduits.
 - c. 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- wide joints to install sealant.
 4. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- 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.
 5. 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.

6. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
 7. 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 instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- B. Install interior gypsum board in the following locations:
1. Type X: Vertical surfaces unless otherwise indicated.
 2. Ceiling Type: Ceiling surfaces.
 3. Impact-Resistant Type: All locations within 8 feet of floor except where tile backing panel is indicated, and other locations as indicated on Drawings.
 4. Tile Backing Panels: Locations to receive tile.
- C. Single-Layer Application:
1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- D. Applying Tile Backing Panels:
1. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.
 2. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.
- E. Installing Trim Accessories: 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.
1. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
 2. Interior Trim: Install in the following locations:
 - a. Cornerbead: Use at outside corners unless otherwise indicated.
 - b. LC-Bead: Use at exposed panel edges.
 - c. L-Bead: Use where indicated.
 - d. U-Bead: Use at exposed panel edges.
 3. Aluminum Trim: Install in locations indicated on Drawings.

3.2 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, unless a higher level of finish is required for sound or fire rated assemblies.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - 4. Level 5: At panel surfaces that will receive gloss paint and other locations indicated on Drawings.

3.3 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 09 2900

SECTION 09 3000 - TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Paver tile.
 - 2. Waterproof membrane for tile installations.
 - 3. Metal edge strips installed as part of tile installations.

1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Samples:
 - 1. Each type, composition, color, and finish of tile.
 - 2. Assembled samples with grouted joints for each type, composition, color, and finish of tile.
 - 3. Metal edge strip in 6-inch lengths.
- C. Product Certificates: For each type of product, signed by product manufacturer.
- D. Qualification Data: For Installer.
- E. Material Test Reports: For each tile-setting and -grouting product.

1.3 QUALITY ASSURANCE

- A. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 TILE PRODUCTS

- A. ANSI Ceramic Tile Standard: Provide Standard grade tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
- B. Unglazed Paver Tile:
 - 1. Products: Subject to compliance with requirements, provide materials as indicated on the material selection schedule.
 - 2. Composition: Porcelain.
 - 3. Facial Dimensions: 11-13/16 by 11-13/16 inches.
 - 4. Thickness: 3/8 inch.
 - 5. Face: Plain with cushion edges.
 - 6. For latex-portland cement-mortared and -grouted paver tile, precoat with temporary protective coating.
- C. Unglazed Paver Tile:
 - 1. Products: Subject to compliance with requirements, provide materials as indicated on the material selection schedule
 - 2. Composition: Porcelain.
 - 3. Thickness: 3/8 inch.
 - 4. Face: Plain with cushion edges.
 - 5. For latex-portland cement-mortared and -grouted paver tile, precoat with temporary protective coating.

2.3 ACCESSORY MATERIALS

- A. Waterproofing Membranes for Thin-Set Tile Installations: Manufacturer's standard product that complies with ANSI A118.10, selected from the following.
 - 1. Where tile is indicated in refrigerators and freezers, provide products with proven successful service at temperatures down to -20 deg. F.
 - 2. Sheet Product: One of the following:
 - a. National Applied Construction Products, Inc.; Strataflex.
 - b. Noble Company (The); Nobleseal TS.
 - c. Compotite Corporation; Composeal Gold.
 - d. Schluter Systems L.P.; KERDI.
 - e. Schluter Systems L.P.; DITRA.
 - 3. Fabric-Reinforced, Fluid-Applied Product: System consisting of liquid-latex rubber and fabric reinforcement.
 - a. Products:
 - 1) Custom Building Products; Trowel & Seal Waterproofing and Anti-Fracture Membrane.
 - 2) LATICRETE International Inc.; Laticrete 9235 Waterproof Membrane.
 - 3) MAPEI Corporation; PRP M19.
 - 4) Summitville Tiles, Inc.; S-9000.

2.4 SETTING AND GROUTING MATERIALS

A. Manufacturers:

1. Bostik Hydroment.
2. Custom Building Products.
3. LATICRETE International Inc.
4. MAPEI Corporation.
5. TEC Specialty Products Inc.

B. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.

1. Provide second generation formulation of prepackaged dry-mortar mix combined with liquid-latex additive.
2. For wall applications, provide nonsagging mortar.

C. Polymer-Modified Tile Grout: ANSI A118.7, color as indicated.

1. Polymer Type: Dry, redispersible form, prepackaged with other dry ingredients.

D. Chemical Resistant Furan Grout: ANSI A118.5.

E. Grout Colors: Match colors as indicated by material selection schedule.

2.5 MISCELLANEOUS MATERIALS

A. Elastomeric Sealants: Elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 07 Section "Joint Sealants."

B. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials.

C. Metal Edge Strips at Flooring Terminations: Angle or L-shape, aluminum with clear anodized finish.

D. Metal Outside Corner and Top of Base Strips: For outside corners where porcelain pavers are installed on wall, provide the following:

1. Basis-of-Design Product: Schluter; Rondec.
2. Material: Aluminum with clear anodized finish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.

- B. Existing GSU Surfaces: Scarify existing GSU surfaces to receive tile. Remove existing cove in GSU base.
- C. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions.
- D. Remove protrusions, bumps, and ridges by sanding or grinding.
- E. Blending: For tile exhibiting color variations, use factory blended tile or blend tiles at Project site before installing.
- F. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.2 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Grind cut edges of tile abutting trim, finish, or built-in items. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- F. Lay out tile bases and wainscots to next full tile beyond dimensions indicated.
- G. Expansion Joints: Locate expansion joints and other sealant-filled joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Locate joints in tile surfaces directly above joints in concrete substrates.
 - 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."
- H. Grout tile to comply with requirements of ANSI A108.10, unless otherwise indicated.

- I. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.
- J. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
 - 1. Tile floors in wet areas.
 - 2. Tile floors composed of tiles 8 by 8 inches or larger.
 - 3. Tile floors composed of rib-backed tiles.
- K. Install tile on floors with the following joint widths:
 - 1.
 - 2. Paver Tile: 3/16 inch.
- L. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile and external corners of paver tile.
- M. Install tile on walls with the following joint widths:
 - 1.
 - 2. Paver Tile: 3/16 inch.
- N. Apply grout sealer to grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.3 FLOOR TILE INSTALLATION SCHEDULE

- A. Interior floor installation on waterproof membrane over concrete; cement mortar bed (thickset); TCA F121.
 - 1. Bond Coat/Thin-Set Mortar: Latex- portland cement mortar.
 - 2. Grout: Polymer-modified unsanded grout for joints less than 1/8 inch and polymer-modified sanded grout for joints more than 1/8 inch.

3.4 WALL TILE INSTALLATION SCHEDULE

- A. Interior wall installation over masonry or concrete; thin-set mortar; TCA W202.
 - 1. Thin-Set Mortar: Latex- portland cement mortar.
 - 2. Grout: Chemical-resistant, water-cleanable, epoxy grout.
- B. Interior wall installation over glass-mat, water-resistant backer board; thin-set mortar; TCA W245.
 - 1. Thin-Set Mortar: Latex- portland cement mortar.
 - 2. Grout: Polymer-modified unsanded grout for joints narrower than 1/8 inch and polymer-modified sanded grout for joints wider than 1/8 inch.

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END OF SECTION 09 3000

SECTION 09 6500 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vinyl composition floor tile.
 - 2. Resilient base.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch sections of each different color and pattern of floor covering required.
 - 1. Base and Molding: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches long, of each resilient product color, texture, and pattern required.
- C. Qualification Data: For qualified Installer.
- D. Maintenance data.

1.3 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 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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.
 - 1. Store floor tiles on flat surfaces.

1.5 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive floor coverings.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.
- 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.

1.6 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. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
 - 2. Resilient Base and Moldings: Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

PART 2 - PRODUCTS

2.1 TILE FLOORING

- A. Vinyl Composition Floor Tile : ASTM F 1066, Class 2, through-pattern tile. Provide materials per the Material Selection Schedule indicated on Drawings.

2.2 RESILIENT BASE

- A. Resilient Rubber Base Provide products as indicated on material selection in drawings.
- B. Resilient Rubber Base (RB-3):

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Trowel-Applied Underlayment: Portland cement-based matrix formulated for skim-coating flooring substrates.
- C. Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.

PART 3 - EXECUTION

3.1 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 as follows in 24 hours.
 - 1) Vinyl Composition Tile: 5 lb of water/1000 sq. ft..
 - 2) Other Flooring: 3 lb of water/1000 sq. ft..
 - b. 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. in 24 hours.
 - c. 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.] <Insert emission>** in 24 hours.
 - d. 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. Existing Buildings: Provide trowel-applied underlayment over all surfaces to receive flooring where existing flooring is removed.
- E. 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.
- F. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.2 FLOOR COVERING INSTALLATION

- A. General: Comply with manufacturer's written instructions for installing floor coverings.

1. 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.
 2. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
 3. 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.
 4. 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.
 5. 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.
- B. Tile Flooring: 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.
 2. 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.
 - a. Lay tiles with grain running in one direction.
 - b. Lay tiles with grain running in one direction.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
1. 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.
 2. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
 3. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
 4. Do not stretch resilient base during installation.
- B. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- C. Preformed Corners: Install preformed corners before installing straight pieces.
- D. 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 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor covering.
- B. Immediately after completing flooring installation, remove adhesive and other blemishes from exposed surfaces, sweep and vacuum surfaces thoroughly, and damp-mop surfaces to remove marks and soil.
- C. Cover floor coverings until Substantial Completion.

END OF SECTION 09 6500

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SECTION 09 9123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on interior substrates.
- B. Related Sections include the following:
 - 1. Division 09 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each finish and for each color and texture required.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Qualification Data: For qualified Installer.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with EPA requirements for lead-based paint activities and renovation for portions of the building built prior to 1978.
- B. Installer Qualifications: Certified by EPA to conduct lead-based paint activities and renovation.
- C. MPI Standards:
 - 1. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.5 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide products indicated in other Part 2 Articles.

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Colors: Match colors indicated.

2.3 BLOCK FILLERS

- A. Interior/Exterior Latex Block Filler:
 - 1. Products: One of the following:
 - a. Benjamin Moore; Moorcraft Super Craft Latex Block Filler No. 285: Applied at a dry film thickness of not less than 8.1 mils.
 - b. Coronado; 946-11 Super Kote 5000 Commercial Latex Block Filler: Applied at a dry film thickness of not less than 8.4 mils.
 - c. Graham; 882-00 Pro Finish Latex Block Filler. Applied at a dry film thickness of not less than 6.0 to 12.5 mils.

- d. Pittsburgh Paints; 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler: Applied at a dry film thickness of not less than 6.0 to 12.5 mils.
- e. P & L; Pro-Hide Heavy Duty Block Filler Z8465. Applied at a dry film thickness of not less than 6.0 to 12.5 mils.
- f. Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils.

2.4 PRIMERS/SEALERS

A. Interior Latex Primer/Sealer:

- 1. Products: One of the following:
 - a. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
 - b. Coronado; 40-11 Super Kote 5000 Latex Primer-Sealer: Applied at a dry film thickness of not less than 1.2 mils.
 - c. Graham; 342-00 Pro Finish Latex Underbody. Applied at a dry film thickness of not less than 1.6 mils.
 - d. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
 - e. P & L; Suprime 4 Interior Latex Wall Primer Z/F1004. Applied at a dry film thickness of not less than 1.2 mils.
 - f. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

B. Interior Plaster Primer/Sealer:

- 1. Products: One of the following:
 - a. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
 - b. Coronado; 40-11 Super Kote 5000 Latex Primer-Sealer: Applied at a dry film thickness of not less than 1.2 mils.
 - c. Graham; 320-00 Aqua Borne Blockout/Undercoat. Applied at a dry film thickness of not less than 2.2 mils.
 - d. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
 - e. P & L; Suprime 1 100% Acrylic Multi-Purpose Primer Z/F1001. Applied at a dry film thickness of not less than 1.5 mils.
 - f. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

2.5 METAL PRIMERS

A. Alkyd Anticorrosive Metal Primer:

- 1. Products: One of the following:

- a. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils.
- b. Coronado; 35-147 Rust Scat Alkyd Metal Primer: Applied at a dry film thickness of not less than 2.0 mils.
- c. Graham; 479-91 Aqua Borne Shop Coat Primer. Applied at a dry film thickness of not less than 2 mils.
- d. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 1.5 mils.
- e. P & L; Suprime 3 Interior/Exterior Latex Metal Primer Z/F1003. Applied at a dry film thickness of not less than 2 mils.
- f. Sherwin-Williams; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils.

B. Waterborne Galvanized-Metal Primer:

1. Products: One of the following:

- a. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils.
- b. Coronado; 36-11 Rust Scat Acrylic Metal Primer: Applied at a dry film thickness of not less than 2.0 mils.
- c. Graham; 100-00 Aqua Borne Ceramic Universal Primer & Stain Blocker. Applied at a dry film thickness of not less than 1.3 mils.
- d. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils.
- e. P & L; Suprime 3 Interior/Exterior Latex Metal Primer Z/F1003. Applied at a dry film thickness of not less than 2 mils.
- f. Sherwin-Williams; primer not required over this substrate.

2.6 LATEX PAINTS

A. Interior Latex (Flat): (Gloss Level 1).

1. Products: One of the following:

- a. Benjamin Moore; Moorecraft Super Spec Latex Flat No. 275: Applied at a dry film thickness of not less than 1.2 mils.
- b. Coronado; 28 Line Super Kote 5000 Latex Flat Paint: Applied at a dry film thickness of not less than 1.2 mils.
- c. Graham; 602-Series Elite Acrylic Latex Flat Wall Paint. Applied at a dry film thickness of not less than 1.2 mils.
- d. Pittsburgh Paints; 6-70 Line SpeedHide Interior Wall Flat-Latex Paint: Applied at a dry film thickness of not less than 1.0 mil.
- e. P & L; Pro-Hide Gold Interior Latex Flat Z8100 Series. Applied at a dry film thickness of not less than 2.0 mils.
- f. Sherwin-Williams; ProMar 200 Interior Latex Flat Wall Paint B30W200 Series: Applied at a dry film thickness of not less than 1.4 mils.

B. Interior Latex (Semigloss): (Gloss Level 5).

1. Products: One of the following:
 - a. Benjamin Moore; Moorcraft Super Spec Latex Semi-Gloss Enamel No. 276: Applied at a dry film thickness of not less than 1.2 mils.
 - b. Coronado; 32-Line Super Kote 5000 Latex Semi-Gloss Enamel: Applied at a dry film thickness of not less than 1.3 mils.
 - c. Graham; 462-Series Elite Interior Latex Semi-Gloss: Applied at a dry film thickness of not less than 1.2 mils.
 - d. Pittsburgh Paints; 6-500 Series SpeedHide Interior Semi-Gloss Latex: Applied at a dry film thickness of not less than 1.0 mil.
 - e. P & L; Pro-Hide Gold Interior Latex Semi-Gloss Z8300 Series. Applied at a dry film thickness of not less than 2.0 mils.
 - f. Sherwin-Williams; ProMar 200 Interior Latex Semi-Gloss Enamel B31W200 Series: Applied at a dry film thickness of not less than 1.3 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Masonry (Clay and CMU): 12 percent.
 2. Gypsum Board: 12 percent.
 3. Plaster: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION AND APPLICATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
 - 2. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
 - 3. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
 - 4. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
 - 5. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
 - 6. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
 - 7. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.
- D. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
 - 1. Existing Buildings: Where new finishes are indicated in existing spaces, paint all existing previously painted items including but not limited to, doors and frames, fire extinguisher cabinets, mechanical devices, electrical panels, and similar items.
- E. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
 - 1. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 2. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 3. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- F. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
 - 1. Mechanical Work:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Tanks that do not have factory-applied final finishes.
 - e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.

- f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
- 2. Electrical Work:
 - a. Switchgear.
 - b. Panelboards.
 - c. Electrical equipment that is indicated to have a factory-primed finish for field painting.

3.3 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.4 CLEANING AND PROTECTION

- A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 09 9123

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SECTION 10 1100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Markerboards (MB -)
2. Tackboards (TB -)
3. Display rails.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For visual display units.

1. Include plans, elevations, sections, details, and attachment to other work.
2. Show locations of panel joints

C. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:

1. Samples of facings for each visual display panel type, indicating color and texture.
2. Fabric swatches of fabric facings for tackboards.
3. Include accessory Samples to verify color selected.

D. Product Schedule: For visual display units.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For visual display units to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Deliver factory-built visual display units 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.

1.7 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 50 years from date of Substantial Completion.
 - 2. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces become slick or shiny.
 - c. Surfaces exhibit crazing, cracking, or flaking.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.

2.2 VISUAL DISPLAY BOARD ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CIG-JAN Products, Ltd.
 - 2. Claridge Products and Equipment, Inc.
 - 3. Marsh Industries, Inc.
 - 4. Platinum Visual Systems.
 - 5. Peninsular.
 - 6. PolyVision Corporation.
- B. Visual Display Board Assembly (MB): Balanced, high-pressure, factory-laminated markerboard assembly of 3-ply construction consisting of backing sheet, core material, and face sheet.

1. Face Sheet: 0.021-inch (0.53 mm) thick, porcelain-enamel with high gloss finish.
 2. Particleboard Core: 3/8 inch (9.5 mm) thick.
 3. Backing: 0.005 inch (0.127 mm) thick aluminum foil backing.
 4. Corners: Square.
 5. Width and Height: As indicated on Drawings.
 6. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.
 7. Color: As selected by Architect from full range of industry colors.
 8. Trim and Accessories: Black finish required for compatibility with technology.
- C. Visual Display Board Assembly (TB): Vinyl-Fabric-Faced cork sheet factory laminated to 1/4-inch (6-mm) thick hardboard backing.
1. Facing: Vinyl fabric factory laminated to 1/4-inch- thick, cork sheet.
 2. Core: 1/4-inch- thick hardboard.
 3. Corners: Square.
 4. Width and Height: As indicated on Drawings.
 5. Color and Pattern: As selected by Architect from full range of industry colors.
- D. Aluminum Frames: Fabricated from not less than 0.062-inch- thick, extruded aluminum; slim size and standard shape.
1. Field-Applied Trim: Manufacturer's standard, snap-on trim with no visible screws or exposed joints.
 2. Aluminum Finish: Black.
- E. Chalktray: Manufacturer's standard; continuous.
1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.
- F. Display Rail: Manufacturer's standard, extruded-aluminum display rail with plastic-impregnated-cork insert, end stops, designed to hold accessories.
1. Size: 1 to 2 inches high by full length of visual display unit.
 2. Map Hooks and Clips: Two map hooks with flexible metal clips for every 48 inches of display rail or fraction thereof.
 3. Flag Holder: One for each room.

2.3 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish; with surface-burning characteristics indicated.
- C. Extruded Aluminum: ASTM B 221, Alloy 6063.
- D. Vinyl Fabric: Mildew resistant, washable, complying with ASTM F 793/F 793M, Type II, burlap weave; weighing not less than 13 oz./sq. yd.; with surface-burning characteristics indicated.
- E. Hardboard: ANSI A135.4, tempered.

- F. Particleboard: ANSI A208.1, Grade M-1.

2.4 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.5 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. Visual Display Boards: Factory assemble visual display boards, unless otherwise indicated.
- C. 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.
 - 2. Provide manufacturer's standard H-trim system between abutting sections of markerboards.
 - 3. Provide manufacturer's standard mullion trim at joints between markerboards and tackboards of combination units.
- D. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and substances that will impair bond between visual display boards and surfaces.
- B. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- C. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
 - 1. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.
 - 2. 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.

- D. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 16 inches o.c. Secure tops and bottoms of boards to walls.

3.2 CLEANING AND PROTECTION

- A. Clean visual display units in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

END OF SECTION 10 1100

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SECTION 10 2800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Washroom accessories.
 - 2. Warm-air dryers.
- B. Owner-Furnished Material: Paper towel dispensers, toilet tissue dispensers, and liquid soap dispensers.
- C. Related Sections include the following:
 - 1. Division 09 Section "Tiling" for ceramic toilet and bath accessories.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule:
 - 1. Identify locations using room designations indicated on Drawings.
 - 2. Identify products using designations indicated on Drawings.
- C. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

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.

1.4 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.5 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- B. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 WASHROOM ACCESSORIES

- A. Basis-of-Design Product: The design for accessories is based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
 - 1. American Specialties, Inc.
 - 2. Bobrick Washroom Equipment, Inc.
 - 3. Bradley Corporation.
 - 4. General Accessory Manufacturing Co. (GAMCO).
- B. Toilet Tissue (Roll) Dispensers: Surface mounted, Owner furnished and Contractor installed.
- C. Paper Towel Dispensers: Surface mounted, Owner furnished and Contractor installed.
- D. Liquid-Soap Dispensers: Surface mounted, Owner furnished and Contractor installed.
- E. Grab Bars:
 - 1. Mounting: Flanges with concealed fasteners.
 - 2. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.
 - 3. Outside Diameter: 1-1/2 inches.
 - 4. Configuration and Length: As indicated on Drawings.
- F. Mirror Units:
 - 1. Frame: Stainless-steel angle, 0.05 inch thick.
 - 2. Hangers: Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

3. Size: 24 by 36 inches unless indicated otherwise.

- G. Robe Hooks: Provide one in each single-occupant toilet room and other locations as indicated.

1. Basis-of-Design Product: Bobrick B-6727.
2. Description: Double-prong unit.
3. Material and Finish: Stainless steel, No. 4 finish (satin).

2.3 WARM-AIR DRYERS

- A. Product: Subject to compliance with requirements, provide the product indicated.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Warm-Air Hand Dryer:

1. Product: World Dryer Corporation; XRA5-Q974.
2. Mounting: Semirecessed.
3. Operation: Electronic-sensor activated with timed power cut-off switch.
 - a. Operation Time: 80 seconds.
4. Cover Material and Finish: Cast iron, with white porcelain enamel finish.
5. Electrical Requirements: 115 V, 20 A, 2300 W.

2.4 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
1. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.
- B. Adjusting and Cleaning: Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

**PROJECT NO. 23-612.00
KPS LOY NORRIX HIGH SCHOOL HEALTH SUITE
KALAMAZOO PUBLIC SCHOOLS**

**TOILET, BATH, AND LAUNDRY ACCESSORIES
10 2800 - 4
ADD #1 - 03-28-2024**

1. Remove temporary labels and protective coatings.
2. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 10 2800

SECTION 10 4413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Fire-protection cabinets for portable fire extinguisher.
- B. Related Requirements:
 - 1. Section 10 4416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
- B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.3 FIRE-PROTECTION CABINET

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. JL Industries, Inc.; a division of the Activar Construction Products Group.
 2. Larsens Manufacturing Company.
 3. Nystrom, Inc.
 4. Potter Roemer LLC.
- B. Cabinet Type: Suitable for fire extinguisher.
1. Cabinet Material: Cold-rolled steel sheet.
 2. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
 3. Rolled-Edge Trim: 2-1/2-inch backbend depth.
 4. Cabinet Trim Material: Same material and finish as door.
 5. Door Material: Steel sheet.
 6. Door Style: Vertical duo panel with frame.
 7. Door Glazing: Tempered float glass (clear).
 8. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - a. Provide recessed door pull and friction latch.
 - b. Provide concealed hinge, permitting door to open 180 degrees.
 9. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
- C. Materials:
1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
 - b. Color: As selected by Architect from manufacturer's full range.
 2. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).
- ## 2.4 FABRICATION
- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
 2. Miter corners and grind smooth.
 3. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Fabricate door frames of one-piece construction with edges flanged.
 3. Miter and weld perimeter door frames and grind smooth.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

- C. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 4413

SECTION 10 4416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
- B. Related Requirements:
 - 1. Section 10 4413 "Fire Protection Cabinets."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ansul Incorporated; Tyco International.
 - 2. Buckeye Fire Equipment Company.
 - 3. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - 4. Kidde Residential and Commercial Division.
 - 5. Larsens Manufacturing Company.
 - 6. Potter Roemer LLC.
- B. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
- C. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 - 1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- D. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with baked-enamel finish.
 - 1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 10 4416

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SECTION 22 0500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Sleeve-seal systems.
4. Sleeves.
5. Stack-sleeve fittings.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Supports and anchorages.

1.2 QUALITY ASSURANCE

- A. Provide plumbing systems, equipment, and materials in accordance with applicable codes and regulations, and with authorities having jurisdiction.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- C. Electrical Characteristics for Plumbing 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.

1.3 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.
- C. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, handling, and up to substantial completion. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion.

1.4 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and sleeves in structural components.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.5 PROJECT COMMISSIONING

- A. Project has an independent commissioning authority (CxA). Contractors for this project shall meet CxA requirements and shall coordinate with and participate in commissioning activities.

1.6 PERFORMANCE REQUIREMENTS

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 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.
- C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall include listing/approval stamp, label, or other markings made to specified standards.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 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, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BA91, silver alloy for refrigerant piping, unless otherwise indicated.
- D. Solvent Cements for Joining Plastic Piping:
 - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 DIELECTRIC FITTINGS

- A. Dielectric Connections: Ground joint, copper unions, ASME B16.18, cast-copper-alloy body, hexagonal stock, with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends; and suitable system fluid, pressure and temperature.

2.4 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Plastic.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.5 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.6 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Cast-Brass Type: With polished, chrome-plated or rough-brass finish and setscrew fastener.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

- D. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- E. Split-Casting Brass Type: With polished, chrome-plated or rough-brass finish and with concealed hinge and setscrew.
- F. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed or exposed-rivet hinge, and spring-clip fasteners.

2.8 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.9 PLUMBING ROOF PENETRATIONS

- A. Pipe Curbs for Single or Multiple Pipe Penetrations: Prefabricated heavy-gage galvanized steel or aluminum curb with mitered and welded corners, minimum 1 1/2 inch thick rigid fiberglass insulation adhered to inside walls, built-in cant and mounting flange for roof decks, wood nailer, and acrylic clad ABS plastic cover(s), PVC boot(s), and stainless steel clamps.. Size as required to suit roof opening and piping. Overall minimum height shall be 12 inches above roof insulation. Pate or equivalent.
 - 1. Provide curbs with level tops and bottoms to match roof slope.
- B. Pipe Curbs for Single Pipe Penetrations: All roof pipe penetrations up to 10" O.D. shall be flashed and sealed using a Pate or equivalent pipe seal, consisting of a spun aluminum base having a minimum five inch roof surface flange, a stepped polyvinyl chloride boot to be secured to the base and the pipe with adjustable stainless steel clamps as furnished.
 - 1. Provide curbs with bottoms to match roof slope.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 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.

1. Drawings are diagrammatic with no attempt made to show every ell, tee, transition, fitting, or appurtenance. Provide installations that are complete in every detail, compliant with all applicable codes, and as required to provide a fully functional and operational system even though every item is not specifically indicated.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping 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.

3.2 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and finished floors according to the following:
 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated or rough-brass finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated or rough-brass finish.
 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.

- e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated or rough-brass finish.
- f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated or rough-brass finish.

3.3 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
 - 1. Sleeves are not required for core-drilled holes.
- 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.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 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.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 9200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.4 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 6200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.

- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.5 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves, galvanized-steel wall sleeves, or galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves, galvanized-steel wall sleeve, or galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
 - b. Piping NPS 6 and Larger: Stack-sleeve fittings.
 - 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

3.7 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs.
- 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- 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. PVC Nonpressure Piping: Join according to ASTM D 2855.
- I. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.8 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Connect piping materials of dissimilar metals as follows:
 - a. In piping NPS 2(DN 50) and smaller, install ground joint unions.

3.9 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Sequence, coordinate, and integrate installations of plumbing equipment.

- B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- E. Install equipment to allow right of way for piping installed at required slope.
- F. Installing contractor shall bear all additional costs, including that of Architect/Engineer redesign and that of other trades, incurred as a result of installation of other than scheduled equipment.
- G. Verify final equipment locations for roughing-in.
- H. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.10 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.11 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 plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.12 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
 - 1. Clean surfaces that will come into contact with grout.
 - 2. Provide forms as required for placement of grout.
 - 3. Avoid air entrapment during placement of grout.
 - 4. Place grout, completely filling equipment bases.
 - 5. Place grout on concrete bases and provide smooth bearing surface for equipment.
 - 6. Place grout around anchors.
 - 7. Cure placed grout.

3.13 PLUMBING ROOF PENETRATIONS

- A. Install plumbing roof penetrations in accordance with roof curb manufacturer's recommendations and in strict compliance with roofing manufacturer's requirements.
 - 1. Roofs with Warranty: Roof penetrations and curbs shall be installed in such a manner to maintain roofing warranty.
- B. Pipe Curbs for Pipe Penetrations: Secure boot to curb base and secure boot to pipe with adjustable stainless steel clamps.

3.14 INSTALLATION OF ACCESS DOORS

- A. Where lay-in ceilings are used, the access to ceiling space is provided through the removable ceiling panels. Where access is required to valves, pipes, or other devices in spaces above non-removable ceilings or in chases, the Contractor requiring the access doors shall provide access doors. Access doors required in rated walls and ceiling shall bear the same rating. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
 - 1. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
 - 2. Adjust hardware and panels after installation for proper operation.

3.15 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 0500

SECTION 22 0523 – GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Bronze swing check valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.3 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.9 for building services piping valves.

C. NSF Compliance as required by authorities having jurisdiction:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
3. Comply with NSF 372, "Drinking Water System Components – Lead Content"

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect valve ends from damage.
3. Set gate valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.

5. Set ball and plug valves open to minimize exposure of functional surfaces.
 6. Set butterfly valves closed or slightly open.
 7. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
1. Handlever: For quarter-turn valves NPS 6(DN 150) and smaller except plug valves.
- E. Valves in Insulated Piping: Valves in domestic cold water lines with more than 1/2-inch(13-mm) insulation shall include the following:
1. Ball Valves: Stem extensions or extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 2. Butterfly Valves: Extended neck.
- F. Valve-End Connections:
1. Grooved: With grooves according to manufacturer.
 2. Solder Joint: With sockets according to ASME B16.18.
 3. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves.
 - b. Crane.
 - c. Hammond Valve.

- d. Milwaukee Valve Company.
- e. NIBCO INC.
- f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig(4140 kPa).
- c. Body Design: Two piece, threaded.
- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE.
- g. Stem: Bronze.
- h. Ball: Bronze.
- i. Port: Full.

2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves.
 - b. Crane.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-139.
 - b. CWP Rating: 200 psig(1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.

- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow.

3.3 ADJUSTING

- A. Adjust or replace leaking valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Valve Applications:
 - 1. Domestic Water:
 - a. Shutoff Service: Ball and butterfly valves.
 - b. Throttling Service: Ball and butterfly valves.
 - c. Check Valves:
 - 1) NPS 2(DN 50) and Smaller: Bronze swing check valves with nonmetallic disc.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2(DN 50) and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, bronze with bronze trim.
 - 3. Bronze Swing Check Valves: Class 125, bronze disc.

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GENERAL DUTY VALVES FOR PLUMBING PIPING
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END OF SECTION 22 0523

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SECTION 22 0529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe positioning systems.
- B. See Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers, and pipe and equipment supports.
- C. See Division 21 fire-suppression sections for pipe hangers for fire-suppression piping.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

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. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon 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 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

- B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, 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 APPLICATIONS

- A. Specific hanger and support requirements are specified 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 metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use thermal-hanger shield inserts for insulated piping and tubing.
- G. 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 120 to 450 deg F pipes, NPS 4 to NPS 16, 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 24, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 6. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 8. 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.
 9. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 10. 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.
- H. 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 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- I. 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.
- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 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.
- K. 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.
- L. 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.
- M. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
 - 1. Use powder-actuated fasteners only in concrete construction that is suitable for their installation.

3.2 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 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 above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:

1. Install powder-actuated fasteners 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.
- F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal movement of piping systems, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
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 according to 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.
 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.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - 5.
 6. Insert Material: Length at least as long as protective shield.
 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- 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 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 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 maximum.

3.5 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 22 0529

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SECTION 22 0553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Stencils.
 - 4. Valve tags.

1.2 ACTION SUBMITTALS

- A. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Tag and identify equipment to comply with Owner's preventative maintenance system. Coordinate with Owner.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 "Pipe Labeling Guide" for color scheme, length of field and letter height.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - a. Size of label shall be proportional to equipment size.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 WARNING SIGNS AND LABELS

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic label including flow arrow formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic label with contact-type, permanent-adhesive backing. Include wrap around flow arrow tape with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service matching designations or abbreviations as used on Drawings.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 1. Stencil Material: Fiberboard or metal.
 2. Stencil Paint: Exterior, gloss, black enamel unless otherwise indicated. Paint may be in pressurized spray-can form.
 3. Identification Paint: Exterior enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link or beaded chain; or S-hook.

- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Provide glass front frame for each valve schedule for mounting in building mechanical room.
 - 2. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Pipe Label Applications: Install pipe labels as follows:
 - 1. For 10 inches (250 mm) and smaller outside diameter including insulation, use pretensioned pipe labels.
 - 2. For larger than 10 inches (250 mm) outside diameter including insulation, use self-adhesive pipe labels.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is concealed above ceilings or exposed in unfinished mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run.

- D. Identify all new mineral fiber pipe insulation with pressure sensitive vinyl markers using wording similar to "asbestos free insulation". Markers shall be blue background with white letters. Install in clear view and align with longitudinal axis. Locate identification not to exceed 30 feet on straight runs including risers and drops, and near each side of penetration of structure or enclosure, and at connection to existing insulation. Coordinate location with other identification markers such that they are intermediately spaced.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Install glass front frame valve schedule in building mechanical room. Locate at Owners representative approved location.

END OF SECTION 22 0553

SECTION 22 0700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulation materials for plumbing systems:
- B. Related Sections include the following:
 - 1. Division 23 Section "HVAC Insulation."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated below. Include thermal conductivity, thickness, and factory applied jackets (if any).
 - 1. Insulation Materials:
 - a. Mineral fiber.
 - b. Flexible elastomeric.
 - 2. Field-applied jackets.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program.
- B. 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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

- B. Coordinate clearance requirements with piping Installer for piping insulation application.
 - 1. Establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- D. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- E. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 200 deg F.
 - 3. Solids Content: 63 percent by volume and 73 percent by weight.
 - 4. Color: White.

2.5 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

C. Self-Adhesive Outdoor Jacket: Minimum 40-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.

1. Coordinate color of optional colors with Architect and Owner.
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Polyguard; Alumaguard.
 - b. MFM Building Products; Flex Clad 400

2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive.

2.9 SECUREMENTS

- A. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- B. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 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.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - 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 pipe flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.

4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations:

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation at roof structure and seal with joint 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.
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 outside wall flashing and overlap wall flashing at least 2 inches.
5. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece

- and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For mineral fiber insulation, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
1. Flexible elastomeric pipe insulation only allowed in concealed or mechanical room locations.
- B. Insulation Installation on Roof Drain Sumps:
1. Install pipe insulation to bottom of roof drain sumps.
 2. Secure insulation to roof drain sumps and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Roof Drain Bodies:

1. Install pipe insulation to bottom of roof drain bodies exposed within building.
2. Secure insulation to roof drain bodies and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. 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.

F. 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.

3.7 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 o.c.
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 Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

- A.** 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 manufacturers 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.
 2. Fill inside of fitting jackets to prevent collapse of jacket.

3.9 FINISHES

- A.** Paintable Jacket Material: Paint jacket with paint system identified in Division 09 painting Sections.

3.10 EQUIPMENT INSULATION SCHEDULE

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A.** Acceptable pipe insulation materials and thicknesses are identified for each piping system and pipe size range.
1. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B.** Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Chrome-plated pipes and fittings.

2. Underground piping.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - b. Flexible Elastomeric: 1/2 inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - b. Flexible Elastomeric: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - b. Flexible Elastomeric: 1 inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.
 - b. Flexible Elastomeric: 1-1/2 inch thick.

C. Floor Drains, Traps, and Sanitary Drain Piping within 20 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - b. Flexible Elastomeric: 1 inch thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Pipe Fittings with Mineral Fiber Insulation:

1. PVC Fitting Covers: 20 mils thick, white.

C. Exposed Vertical Piping within 8 feet of Floor:

1. PVC: 30 mils thick, white.
2. Aluminum, Smooth or Stucco Embossed: 0.024 inch thick.

END OF SECTION 22 0700

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SECTION 22 0800 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes commissioning process requirements for plumbing systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.
 - 2. Division 23 Section "Commissioning of HVAC" for HVAC commissioning requirements.
 - 3. Division 26 Section "Commissioning of Electrical Systems" for electrical systems commissioning requirements.

1.2 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 ALLOWANCES

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA as defined in the Commissioning Plan.
- B. Attend construction phase commissioning coordination meeting.
- C. Participate in plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- D. Provide information requested by the CxA for final commissioning documentation.
- E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- F. Provide training to Owner's personnel on system operations, preventive maintenance, sequence of operations, and general function on systems.

1.5 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual plumbing systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.6 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for plumbing systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that plumbing systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.

1.7 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

- C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing Work, and provide access for the CxA to witness testing Work.
- C. Provide technicians, instrumentation, and tools to verify testing of plumbing systems at the direction of the CxA.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. 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.
- D. The CxA along with the plumbing Installer shall prepare detailed testing plans, procedures, and checklists for plumbing systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. 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.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. 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.
- I. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to the Construction Manager CxA Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Domestic Water Heater Testing and Acceptance Procedures: Testing requirements are specified in Division 22 water heater Sections. Provide submittals, test data, inspection record, and heater certification to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements for domestic water heater recirculation pump control and monitoring domestic water heater temperature specified in Division 23 Section "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Domestic water pipe system cleaning, flushing, hydrostatic tests, and disinfecting requirements are specified in Division 22 piping Sections. Plumbing Installer shall prepare a pipe system cleaning, flushing, hydrostatic testing and disinfection plan. Provide cleaning, flushing, testing, and disinfection plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and disinfection plan.
 - 2. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and disinfected.

END OF SECTION 22 0800

SECTION 22 1116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes domestic water piping inside the building.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and fittings.
 - 2. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.3 ACTION SUBMITTALS

1.4 INFORMATIONAL SUBMITTALS

- A. Water Samples: Specified in Part 3 "Cleaning" Article.
- B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. NSF Compliance as required by authorities having jurisdiction:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
 - 3. Comply with NSF 372, "Drinking Water System Components – Lead Content"

1.6 REGULATORY REQUIREMENTS

- A. Comply with the provisions of the following:
 - 1. Michigan Plumbing Code.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Schedule 40, galvanized. Include ends matching joining method.
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39, Class 150, galvanized, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
 - 3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
 - 4. Cast-Iron Flanges: ASME B16.1, Class 125, galvanized.
 - 5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.
 - 6. Steel-Piping, Grooved-End Fittings: ASTM A 47/A 47M, galvanized, malleable-iron casting; ASTM A 106, galvanized steel pipe; or ASTM A 536, galvanized, ductile-iron casting; with dimensions matching steel pipe.
 - a. Grooved-End-Pipe Couplings: AWWA C606, for steel-pipe dimensions. Include galvanized ferrous housing sections, gasket suitable for domestic water, and bolts and nuts.
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International, Inc.
 - 2) Victaulic Company of America.

2.3 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Types K , water tube, annealed temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
- B. Hard Copper Tube: ASTM B 88, Types L , water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - 4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

- a. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for domestic water, and bolts and nuts.
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International, Inc.
 - 2) Victaulic Company of America.
 - 3) Tyco/Grinnell.

2.4 MECHANICAL JOINT COPPER PRESS FITTING SYSTEM

- A. At the Installer's option, Ridgid/Viega "ProPress" or NIPCO "Press" mechanical joint copper press fitting system using Type L copper tubing may be used for 4 inch and smaller above ground domestic water systems in lieu of soldered, threaded, grooved and flanged connections as specified.
- B. Provide manufacturer's standard mechanical joint copper press fittings and couplings which are suitable for the temperature range and operating pressures specified for each system and have the approval of state and local codes having jurisdiction.
- C. Fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for fittings shall be EPDM.
- D. Manufacturers: Subject to compliance with requirements, provide product by one of the following:
 - 1. Ridgid/Viega "ProPress"
 - 2. NIBCO "Press"
 - 3. Apollo "Xpress"

2.5 VALVES

- A. Bronze and cast-iron, general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Balancing and drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPE AND FITTING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.

- C. Grooved joints may be used on aboveground grooved-end piping.
- D. Aboveground Domestic Water Piping: Use any of the following piping materials for each size range:
 - 1. NPS 1/4 and Smaller for Dishwasher, Coffee Maker, and Refrigerator Final Connection: Soft copper tube, Type L; copper fittings; and soldered or compression joints.
 - 2. NPS 1 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 3. NPS 1-1/4 and NPS 1-1/2: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 4. NPS 2: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 5. NPS 2-1/2 : Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 6. NPS 3: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 7. NPS 4: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 - 8. NPS 2: Hard copper tube, Type L with grooved ends; copper grooved-end fittings; grooved-end-tube couplings; and grooved joints.
 - 9. NPS 2-1/2 : Hard copper tube, Type L with grooved ends; copper grooved-end fittings; grooved-end-tube couplings; and grooved joints.
 - 10. NPS 3: Hard copper tube, Type L with grooved ends; copper grooved-end fittings; grooved-end-tube couplings; and grooved joints.
 - 11. NPS 4: Hard copper tube, Type L with grooved ends; copper grooved-end fittings; grooved-end-tube couplings; and grooved joints.
- E. At Installer's option for aboveground domestic water piping, install Type L, drawn copper tube with mechanical joint copper press fittings for pipe sizes 4 inches and smaller.
 - 1. Valves with bodies meeting requirements of Section "General Duty valves for Plumbing Piping" may be used in mechanical joint copper press systems

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use bronze ball valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Cast-iron, grooved-end valves may be used with grooved-end piping.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves at low points in water mains, risers, and branches.
- D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."

3.4 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- D. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

3.5 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- D. Press Connections: Copper press fitting connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.

- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 4: 12 feet with 5/8-inch rod.
 - 2. NPS 5 : 12 feet with 3/4-inch rod.
 - 3. NPS 6: 12 feet with 3/4-inch rod.
- F. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 4: 10 feet with 1/2-inch rod.
- G. Install supports for vertical copper tubing every 10 feet.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.

3.8 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. 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:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
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.

3.9 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new domestic water piping before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 22 1116

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SECTION 22 1119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Balancing valves.
 - 3. Temperature-actuated water mixing valves.
 - 4. Strainers.
 - 5. Drain valves.
 - 6. Water hammer arresters.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers and pressure gages in domestic water piping.
 - 2. Division 22 Section "Sanitary Waste Piping Specialties" for trap seal protection device.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Backflow Prevention Assembly Test Report

1.6 QUALITY ASSURANCE

- A. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
3. Comply with NSF 372, "Drinking Water System Components – Lead Content"

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Spill-Resistant Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

B. Anti-Siphon Spill-Resistant Vacuum Breakers:

1. Model: Watts 008PCQT
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:
 - a. Valves: Tee handle ball type, on inlet and outlet.

2.2 CALIBRATED BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett Div.
 - b. Tour Andersson.
2. Type: Ball valve with two readout ports and memory setting indicator.
3. Body: Bronze.
4. Size: Same as connected piping, but not larger than NPS 2.

2.3 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Controls.
 - b. Cash Acme.
 - c. Apollo/Conbraco Industries, Inc.
 - d. Honeywell Water Controls.
 - e. Lawler Manufacturing Company, Inc.

- f. Leonard Valve Company.
 - g. Powers; a Watts Industries Co.
 - h. Watts Industries, Inc.; Water Products Div.
 - i. Zurn Plumbing Products Group; Wilkins Div.
-
- 2. Standard: ASSE 1070, thermostatically controlled water tempering valve.
 - 3. Standard: ASSE 1016, thermostatically controlled water tempering valve.
 - 4. Pressure Rating: 125 psig minimum, unless otherwise indicated.
 - 5. Body: Bronze or brass body with corrosion-resistant interior components.
 - 6. Temperature Control: Adjustable.
 - 7. Inlets and Outlet: Threaded with integral check valves.
 - 8. Finish: Rough or chrome-plated bronze.
 - 9. Tempered-Water Setting: 110 deg F.

2.4 STRAINERS FOR DOMESTIC WATER PIPING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Ames.
- 2. Apollo.
- 3. Watts.
- 4. Mueller
- 5. Wilkins.

B. Y-Pattern Strainers:

- 1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
- 2. Body: Bronze for NPS 2 and smaller; cast iron for NPS 2-1/2(DN 65) and larger].
- 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2(DN 65) and larger.
- 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
- 5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
- 6. Drain: Pipe plug for NPS 2 and smaller; Factory-installed, hose-end drain valve for NPS 2-1/2 and larger.

2.5 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

- 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
- 2. Pressure Rating: 400-psig minimum CWP.
- 3. Size: NPS 3/4.
- 4. Body: Copper alloy.
- 5. Ball: Chrome-plated brass.
- 6. Seats and Seals: Replaceable.
- 7. Handle: Vinyl-covered steel.

8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.6 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install calibrated balancing valves in locations where they can easily be adjusted.
- C. Install Y-pattern strainers for water on supply side of each inline pump and elsewhere as indicated.
- D. Install individual water tempering valves at each connection to all lavatories and sinks in accordance with manufacturers' recommendations and in compliance with the plumbing code and authority having jurisdiction.
- E. Install water hammer arresters in water piping according to PDI-WH 201.
- F. Install vacuum breakers at each connection to janitors closet soap dispenser in accordance with manufacturers' recommendations and in compliance with the plumbing code and authority having jurisdiction.

jurisdiction. Locate in same room as equipment being connected and so they are easily accessible for maintenance and periodic testing.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each backflow preventer according to authorities having jurisdiction and the device's reference standard.
 - 2. Test each domestic water piping specialty according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.4 ADJUSTING

- A. Set field-adjustable flow set points of balancing valves.
- B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 1119

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SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes soil and waste, sanitary drainage and vent piping inside the building.
- B. The following Sections contain related requirements:
 - 1. Division 22 Section "Sanitary Waste Piping Specialties" for soil, waste, and vent piping system specialties.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 REGULATORY REQUIREMENTS

- A. Comply with the provisions of the following:
 - 1. Michigan Plumbing Code.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

- B. Hub-and-Spigot, Cast-Iron Pipe and Fittings: ASTM A 74, Service class.
 - 1. Gaskets: ASTM C 564, rubber.
- C. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 and CISPI 301.
 - 1. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
- D. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.
 - 1. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
 - a. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
- E. Solid-Wall PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- F. Cellular-Core PVC Pipe: ASTM F 891, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Aboveground, soil, waste, and vent piping NPS 1 1/2(DN 40) and smaller shall be any of the following:
 - 1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
 - 2. Steel pipe, drainage fittings, and threaded joints.
 - 3. PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - a. PVC above ground only allowed in concealed locations.
- B. Aboveground, soil, waste, and vent piping NPS 2(DN 50) through NPS 10(DN 250) shall be any of the following:
 - 1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
 - 2. PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.2 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- E. Install soil and waste drainage and vent piping at the minimum slopes required by plumbing code.
- F. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- G. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.
 - 1. For indoor applications, use PVC glue that has a VOC content of 510 g/L or less.
 - 2. For indoor applications, use PVC primer that has a VOC content of 550 g/L or less.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 10: 60 inches with 7/8-inch rod.
 - 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3: 12 feet with 1/2-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 - 2. NPS 3: 48 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 - 4. NPS 6: 48 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 10: 48 inches with 7/8-inch rod.
- J. Install supports for vertical PVC piping every 48 inches.

3.5 CONNECTIONS

- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to other Division 22 plumbing fixtures sections.
 - 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 drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Sanitary Waste Piping Specialties."
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 48 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 drainage and vent piping according to procedures of authorities having jurisdiction.
 - 1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 2. Prepare reports for tests and required corrective action.
- E. Test piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced forced main piping until it has been tested and approved. 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. Isolate test source and allow to stand for four hours. 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.

3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.8 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 22 1316

SECTION 22 1319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Trap-seal protection devices.

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed End of Pipe Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Sioux Chief Mfg. Co.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

- B. Cast-Iron Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

- c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Light Commercial Operation.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Adjustable housing.
 - 5. Body or Ferrule: Cast iron.
 - 6. Outlet Connection: Spigot.
 - 7. Closure: Brass plug with straight threads and gasket.
 - 8. Adjustable Housing Material: Cast iron with threads.
 - 9. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 - 10. Frame and Cover Type:
 - a. Ceramic, Mosaic & Quarry Tile Floors: Terrazzo top type with square nickel bronze top.
 - b. Asphalt & Vinyl Tile Floors: Tile top type with square nickel bronze top.
 - c. Terrazzo Floors: Terrazzo top type with round nickel bronze top.
 - d. Carpet Floors: Carpet flange type with round nickel bronze top.
 - e. Other Finished Floors: Heavy duty type with round nickel bronze top.
 - f. Unfinished Concrete Floors: Heavy duty type with round cast iron top.

C. Cast-Iron Interior Finished Wall Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M. Include wall access.
- 3. Size: Same as connected drainage piping.
- 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk, drilled-and-threaded brass plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 7. Wall Access: Round, flat, stainless-steel cover plate with screw.

D. Cast-Iron Interior Unfinished Accessible Area Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M.
- 3. Size: Same as connected drainage piping.
- 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains - General:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.

B. Cast Iron Floor Drains: Coated gray iron body having integral double drainage flange with weep holes and no-hub spigot or push-on bottom outlet. Provide flashing clamp device where located in membrane floor or when flashing is required for pans. Floor drain type designations and sizes are indicated on Drawings and scheduled below:

1. FD-1: Toilet rooms and finished areas not specifically noted, "Wade" 1100G6 or equivalent with 6 inch (150 mm) square nickel bronze adjustable top, and plugged trap primer tap.

2.3 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:

1. Subject to compliance with requirements, provide SureSeal Manufacturing Inline Floor Drain Trap Sealer, MIFAB MI-GARD Trap Seal, or Jay R. Smith Model 2692 Trap Seal.
2. Standard: ASSE 1072.
3. Size: 2 inch thru 4 inch as required

2.4 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Install wall cleanouts in all finished spaces.
 - 2. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 3. Locate at each change in direction of piping greater than 45 degrees.
 - 4. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 5. Locate at base of each vertical soil and waste stack.
 - 6. For cleanouts at grade within 5'-0" of building install cleanouts and extension from drain pipe to cleanout at grade where indicated. Set cleanout in poured concrete block 18 inches by 18 inches by 12 inches deep, except where location is in concrete paving. Set top of cleanout 1 inch above surrounding earth grade or flush with grade when installed in paving.
 - 7. Align square tops parallel with building walls.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
 - 5. Align square tops parallel with floor tile.
- F. Install trap-seal protection devices at floor sink and floor drain outlets (omit at shower floor drains) during trim out stage of project.
- G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- H. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- I. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 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.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain grease interceptors.

END OF SECTION 22 1319

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SECTION 22 4000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes commercial plumbing fixtures and related components.
- B. Related Sections include the following:
 - 1. Division 10 Section "Toilet, Bath, and Laundry Accessories" for plastic under lavatory trap and supplies insulation kit.
 - 2. Division 22 Section "Domestic Water Piping Specialties" for mixing valves and specialty fixtures not included in this Section.

1.2 DEFINITIONS

- A. Barrier-Free Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Piping and general-duty valves are included where indicated. Fittings specified in this Section include:
 - 1. Supplies and stops.
 - 2. Faucets and spouts.
 - 3. Drains and tailpieces.
 - 4. Traps and waste pipes.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

- 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. Regulatory Requirements: Comply with the following:
 - 1. Michigan Building Code (ANSI117) for plumbing fixtures for people with disabilities.
 - 2. Michigan Plumbing Code.
 - 3. Local authority having jurisdiction.
 - 4. Michigan and local Department of Health requirements.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. NSF Standard: Comply with NSF 372, "Drinking Water System Components – Lead Content" for all components that will be in contact with potable water.
- G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with specified requirements, provide commercial grade plumbing fixtures by one of the following:
 - 1. Lavatories, Water Closets:
 - a. American Standard
 - b. Crane
 - c. Kohler
 - d. Zurn
 - e. Mansfield
 - f. Sloan
 - 2. Faucets:
 - a. Chicago Faucet
 - b. American Standard
 - c. Chicago Faucet
 - d. Elkay
 - e. Kohler
 - f. T & S Brass
 - g. Delta
 - h. Speakman
 - i. Symmons
 - j. Zurn

3. Water Closet Seats:
 - a. Bemis
 - b. Church
 - c. Olsonite
 - d. American Standard
 - e. Centoco
 - f. Eljer
 - g. Kohler
4. Tempering Mixing Valves:
 - a. Powers
 - b. Leonard
 - c. Symmons
 - d. Armstrong-Lynnwood
 - e. Bradley
5. Fixture Supports:
 - a. Josam
 - b. Wade
 - c. Zurn
 - d. Jay R. Smith
 - e. MIFAB
 - f. Watts.

2.2 WATER CLOSETS

- A. WC-1L Water Closets (Barrier-Free Floor Mounted): Vitreous china, tank type, pressure-assisted, bottom outlet, floor mounted 1.28 gallon elongated bowl water closet, white in color; Kohler "Highline" Model K-3999 [(left hand trip lever)]. Provide floor flange, brass bolts, nuts, washers and bolt caps. Provide TS-1 seat, and supply and stop as specified in the Articles below.

2.3 LAVATORIES

- A. LAV-1 Lavatories: 20" x 18" vitreous china lavatory, white in color, with backsplash, front overflow, and chrome plated non-removable grid strainer with tailpiece, fabricated for concealed arm or wall hanger supports. Drill lavatories for 4" faucets. American Standard "Lucerne" Model 0355.012 or equivalent. Provide concealed arm carriers, F-1 faucet, trap, and supplies and stops as specified in the Articles below. (Refer to mounting heights schedule for Barrier-Free requirements.)
 1. Provide offset tailpiece on barrier-free units.
 2. Provide thermostatic mixing valve on hot water line to barrier-free lavatory faucet. Mount below lavatory within trap shield. Refer to Section 22 1119 for mixing valve.
 3. Refer to Division 05 section "Metal Fabrications" for stainless steel under lavatory protection shields.

2.4 SINKS

- A. SK-1 Stainless Steel Sinks (Barrier-Free): 17" x 22" x 5 1/2" deep self-rimming, single compartment sink, with center back drain location; LKAD-18 chrome plated brass grid drain/1-1/2" offset tailpiece; drilled for 8" center faucet (3 holes). Fabricate sink from 18-gage, Type 304 stainless steel conforming to ASTM A167, finished one side only in accordance with ASTM A 480 No. 4 finish, and sound deadened. Elkay Model LRAD-1722 or equivalent. Provide F-2 faucet, trap, and supplies and stops as specified in the Articles below.
1. Provide thermostatic mixing valve on hot water line to sink faucet. Mount below sink as high as possible. Refer to Section 22 1119 for mixing valve.
 2. Provide offset tailpiece for barrier-free units.

2.5 FAUCETS

- A. F-1 Lavatory Faucet: Polished chrome plated cast brass, 4" center set, rigid gooseneck spout with 0.5 gpm chrome plated laminar flow outlet, 4" wrist blade handles. Chicago Faucet Model 895-317GN2AE72ABCP or equivalent.
- B. F-2 Sink Faucet: Polished chrome plated cast brass, 8" center set, swing gooseneck spout with 2.2 gpm chrome plated laminar flow outlet and 4" wrist blade handles. Chicago Faucet Model 786- E29CP or equivalent.

2.6 TOILET SEATS

- A. TS-1 Elongated, heavy duty, solid white plastic toilet seats with molded-in bumpers, closed back/open front, less cover, and having stainless steel check hinge and stainless steel nuts. Centoco Model 500STSCC or equivalent.

2.7 FIXTURE SUPPORTS

- A. General: All Fixture support carriers to conform to ANSI A112.6.1M (American National Standards Institute).

2.8 FITTINGS, TRIM AND ACCESSORIES

- A. Fittings for Plumbing Fixtures: Fittings include the following:
1. Supply Inlets: Copper tube, size required for final connection.
 2. Supply Stops: Chrome-plated brass body, angle or straight configuration with compression fittings, loose-key type; size to match inlet pipe and supply riser.
 3. Supply Risers: 3/8-inch OD flexible chrome-plated brass tube with 1/2-inch IPS straight or offset, knob-end tailpiece.
 4. Traps: Chrome-plated, 17 gauge tubular brass P-trap and wall bend, with slip-joint inlet, wall flange, and escutcheon; same size as fixture outlet connection.
 - a. For concealed applications, ASTM F 409 PVC one or two-piece trap and waste to wall maybe used.

2.9 UNDER-LAVATORY GUARDS

A. Under-Lavatory Guard:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Plumberex Specialty Products, Inc.
 - b. Truebro by IPS Corporation.
 - c. ProFlo
2. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
3. Material and Finish: Antimicrobial, molded plastic, white.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install counter-mounting fixtures in and attached to casework.
- H. Install fixtures level and plumb according to roughing-in drawings.

- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install toilet seats on water closets.
- M. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- N. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- O. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."
- P. Install under-lavatory insulation kits at all lavatory and sink locations in accordance with the following:
 - 1. Cover hot- and cold-water supply risers, stops and handles, tailpiece, trap, and wall bend. Install in accordance with manufacturer's installation instructions. Trim connectors flush so no sharp edges remain.
- Q. Install under-lavatory protective shield at barrier-free wall mounted lavatory locations in accordance with manufacturer's installation instructions.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Adjust mixing valve maximum temperature limit stop in accordance with manufacturers' recommendations and in compliance with the plumbing code and authority having jurisdiction.
- D. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

3.8 FIXTURE HEIGHT SCHEDULE

- A. Install fixtures to heights above finished floor as indicated.
 - 1. Water Closet:
 - a. Standard: 15 inches to top of bowl rim.

- b. Barrier Free: 17 to 19 inches, top of seat.
- 2. Lavatory:
 - a. Standard: 31 inches to top of basin rim.
 - b. Barrier Free: 34 inches to top of basin rim.

3.9 FIXTURE ROUGH-IN SCHEDULE

- A. Line sizes indicated below are run-out sizes, reduce size as required at connection to fixture. Main lines and drops shall be installed in sizes as indicated on drawings.

- 1. Water Closet (Tank Type):
 - a. Cold Water: 3/4 Inch.
 - b. Waste: 4 Inch.
 - c. Vent: 2 Inch.
- 2. Lavatory:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 Inch.
 - d. Vent: 1-1/4 Inch.
- 3. Sink:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 2 Inch.
 - d. Vent: 1-1/2 Inch.

END OF SECTION 22 4000

SECTION 23 0500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Sleeve-seal systems.
4. Sleeves.
5. Stack-sleeve fittings.
6. Escutcheons.
7. Floor plates.
8. Grout.
9. HVAC demolition.
10. Equipment installation requirements common to equipment sections.
11. Painting and finishing.
12. Supports and anchorages.

1.2 QUALITY ASSURANCE

- A. Provide HVAC systems, equipment, and materials in accordance with Michigan Mechanical Code and other applicable codes and regulations, and with authorities having jurisdiction.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- C. 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.
- D. 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. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.3 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. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to

prevent damage during shipment, storage, handling, and up to substantial completion. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion.

1.4 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- A. Coordinate installation of required supporting devices and sleeves in structural components.
- B. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.5 PROJECT COMMISSIONING

- A. Project has an independent commissioning authority (CxA). Contractors for this project shall meet CxA requirements and shall coordinate with and participate in commissioning activities.

1.6 PERFORMANCE REQUIREMENTS

PART 2 - PRODUCTS

2.1 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.
- C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall include listing/approval stamp, label, or other markings made to specified standards.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 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.

- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAu1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 DIELECTRIC FITTINGS

- A. Dielectric Connections: Ground joint, copper unions, ASME B16.18, cast-copper-alloy body, hexagonal stock, with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends; and suitable system fluid, pressure and temperature.

2.4 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Plastic.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.5 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.6 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Cast-Brass Type: With polished, chrome-plated or rough-brass finish and setscrew fastener.
- C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- D. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- E. Split-Casting Brass Type: With polished, chrome-plated or rough-brass finish and with concealed hinge and setscrew.
- F. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed or exposed-rivet hinge, and spring-clip fasteners.

2.8 FLOOR PLATES

- A. Description: Manufactured floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- B. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- C. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.9 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.

2.10 MECHANICAL ROOF PENETRATIONS

- A. Roof Curbs for Duct Penetrations: Prefabricated heavy-gage galvanized steel or aluminum curb with mitered and welded corners, minimum 1 1/2 inch thick rigid fiberglass insulation adhered to inside walls, built-in cant and mounting flange for roof decks, and wood nailer. Size as required to suit roof opening and ductwork. Overall minimum height shall be 12 inches above roof insulation. Provide curbs with level tops and bottoms to match roof slope. Provide galvanized steel flashing and seal water tight. Provide insulation on interior flashing surfaces exposed to building air. Pate or equivalent.
- B. Pipe Curbs for Single or Multiple Pipe Penetrations: Prefabricated heavy-gage galvanized steel or aluminum curb with mitered and welded corners, minimum 1 1/2 inch thick rigid fiberglass insulation adhered to inside walls, built-in cant and mounting flange for roof decks, wood nailer, and acrylic clad ABS plastic cover(s), PVC boot(s), and stainless steel clamps.. Size as required to suit roof opening and

piping. Overall minimum height shall be 12 inches above roof insulation. Provide curbs with level tops and bottoms to match roof slope. Pate or equivalent.

- C. Pipe Curbs for Single Pipe Penetrations: All roof pipe penetrations up to 10" O.D. shall be flashed and sealed using a Pate or equivalent pipe seal, consisting of a spun aluminum base having a minimum five inch roof surface flange, a stepped polyvinyl chloride boot to be secured to the base and the pipe with adjustable stainless steel clamps as furnished.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC 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. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. 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 23 Sections specifying piping systems.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping 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. Offset piping at coils to allow for coil removal.
- K. Select system components with pressure rating equal to or greater than system operating pressure.

3.3 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and finished floors according to the following:
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated or rough-brass finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated or rough-brass finish.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated or rough-brass finish.
 - f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated or rough-brass finish.

3.4 FLOOR PLATE INSTALLATION

- A. Install floor plates for piping penetrations of equipment-room floors.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.5 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
 - 1. Sleeves are not required for core-drilled holes.
- 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.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 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.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 9200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.6 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 6200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 8413 "Penetration Firestopping."

3.7 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.8 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves, galvanized-steel wall sleeves, or galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves, galvanized-steel wall sleeve, or galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
 - b. Piping NPS 6 and Larger: Stack-sleeve fittings.
 - 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

3.9 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 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.

3.10 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Connect piping materials of dissimilar metals as follows:
 - a. In piping NPS 2(DN 50) and smaller, install ground joint unions.

3.11 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Sequence, coordinate, and integrate installations of mechanical equipment, giving particular attention to large equipment requiring positioning prior to closing in the building.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. 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.

- E. Install equipment to allow right of way for piping installed at required slope.
- F. Installing contractor shall bear all additional costs, including that of Architect/Engineer redesign and that of other trades, incurred as a result of installation of other than scheduled equipment.
- G. Verify final equipment locations for roughing-in.
- H. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.12 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.13 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 HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.14 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
 - 1. Clean surfaces that will come into contact with grout.
 - 2. Provide forms as required for placement of grout.
 - 3. Avoid air entrapment during placement of grout.
 - 4. Place grout, completely filling equipment bases.
 - 5. Place grout on concrete bases and provide smooth bearing surface for equipment.
 - 6. Place grout around anchors.
 - 7. Cure placed grout.

3.15 MECHANICAL ROOF PENETRATIONS

- A. Install mechanical roof penetrations in accordance with roof curb manufacturer's recommendations and in strict compliance with roofing manufacturer's requirements.
 - 1. Roofs with Warranty: Roof penetrations and curbs shall be installed in such a manner to maintain roofing warranty.
- B. Roof Curbs for Duct Penetrations: Provide galvanized steel flashing and seal water tight. Provide insulation on interior flashing surfaces exposed to building air.

- C. Pipe Curbs for Pipe Penetrations: Secure boot to curb base and secure boot to pipe with adjustable stainless steel clamps.

3.16 INSTALLATION OF ACCESS DOORS

- A. Where lay-in ceilings are used, the access to ceiling space is provided through the removable ceiling panels. Where access is required to valves, pipes, dampers or other devices in spaces above non-removable ceilings or in chases, the Contractor requiring the access doors shall provide access doors. Access doors required in rated walls and ceiling shall bear the same rating. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
 - 1. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
 - 2. Adjust hardware and panels after installation for proper operation.

3.17 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 23 0500

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SECTION 23 0513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory.
- B. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 ACTION SUBMITTALS

- A. Product Data: For each shaft grounding ring.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.
- B. For motors using variable frequency controller, motors to be designed for such application and suitable for use throughout speed range without overheating.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
 - 1. Provide premium efficient motors where scheduled or when used with a variable frequency controller.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Class B.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Manufacturer's standard material.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with controller.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Shaft Grounding Ring: Factory or field installed Aegis Model SGR shaft grounding ring consisting of a maintenance free, circumferential, bearing protection ring with conductive micro fiber shaft contacting material.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 ELECTRONIC COMMUTATION MOTOR (ECM)

- A. Description: Motor to be an electronic commutation motor (ECM) specifically designed for direct drive fan applications. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.

PART 3 - EXECUTION

3.1 SHAFT GROUNDING RING INSTALLATION

- A. If not factory installed, field install at each three phase motors utilizing a variable frequency controller a shaft grounding ring. Attach according to manufacturer's written instructions.

END OF SECTION 23 0513

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SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Stencils.
 - 4. Valve tags.

1.2 ACTION SUBMITTALS

- A. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Tag and identify equipment to comply with Owner's preventative maintenance system. Coordinate with Owner.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 "Pipe Labeling Guide" for color scheme, length of field and letter height.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - a. Size of label shall be proportional to equipment size.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic label including flow arrow formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic label with contact-type, permanent-adhesive backing. Include wrap around flow arrow tape with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service matching designations or abbreviations as used on Drawings.

2.3 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 1. Stencil Material: Fiberboard or metal.
 2. Stencil Paint: Exterior, gloss, black enamel unless otherwise indicated. Paint may be in pressurized spray-can form.
 3. Identification Paint: Exterior enamel in colors according to ASME A13.1 unless otherwise indicated.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link or beaded chain; or S-hook.

- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Provide glass front frame for each valve schedule for mounting in building mechanical room.
 - 2. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Pipe Label Applications: Install pipe labels as follows:
 - 1. For 10 inches (250 mm) and smaller outside diameter including insulation, use pretensioned pipe labels.
 - 2. For larger than 10 inches (250 mm) outside diameter including insulation, use self-adhesive pipe labels.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
- C. Locate pipe labels where piping is concealed above ceilings or exposed in unfinished mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run.
- D. Identify all new mineral fiber pipe insulation with pressure sensitive vinyl markers using wording similar to "asbestos free insulation". Markers shall be blue background with white letters. Install in clear view and align with longitudinal axis. Locate identification not to exceed 30 feet on straight runs including risers and

drops, and near each side of penetration of structure or enclosure, and at connection to existing insulation. Coordinate location with other identification markers such that they are intermediately spaced.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; equipment shutoff valves; convenience and hose connections; and HVAC terminal devices and similar roughing-in connections of end-use units. List tagged valves in a valve schedule.
- B. Install glass front frame valve schedule in building mechanical room. Locate at Owners representative approved location.

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems.
2. Testing, Adjusting, and Balancing Equipment.
3. Testing, adjusting, and balancing existing systems and equipment.
4. Sound tests.
5. Vibration tests.
6. Duct leakage tests.
7. Control system verification.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
1. Minimum Agenda Items:
- a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.
 - e. Schedule

1.4 INFORMATIONAL SUBMITTALS

- A. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- B. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- C. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- D. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- E. Certified TAB Reports: Submit four copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC NEBB or TABB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 FIELD CONDITIONS

- A. Owner Occupancy: Owner will occupy the site and existing building during TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Perform TAB after leakage and pressure tests on distribution systems have been satisfactorily completed.

1.8 PROJECT COMMISSIONING

- A. Project has an independent commissioning authority (CxA). TAB Specialists for this project shall meet CxA requirements and shall coordinate with and participate in commissioning activities.

PART 2 - EXECUTION

2.1 TAB SPECIALISTS

- A. Subject to compliance with requirements, engage one of the following:
 - a. International Test and Balancing, Inc.
 - b. Quality Air Service, Inc.
 - c. Control Solutions.
 - d. Mechanical Testing Services, Inc.
 - e. Great Lakes Balancing.
 - f. Third Coast Testing and Balancing.
 - g. Aireconomics.

2.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- D. Examine the approved submittals for HVAC systems and equipment.
- E. 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.
- F. Examine ceiling plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

- G. Examine equipment performance data.
- H. Examine system and equipment installations and verify that field quality-control testing, **cleaning**, and adjusting specified in individual Sections have been performed.
- I. Examine test reports specified in individual system and equipment Sections.
- J. Examine HVAC equipment and verify that equipment with functioning controls is ready for operation.
- 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 strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- M. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- O. Examine system pumps to ensure absence of entrained air in the suction piping.
- P. Examine operating safety interlocks and controls on HVAC equipment.
- Q. 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.

2.3 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include in the report, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.

- j. Suitable access to balancing devices and equipment is provided.

2.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance"; ASHRAE 111; NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"; SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing"; and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 3300 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 0700 "HVAC Insulation."
 - 4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 0700 "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

2.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.

- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 23 3113 "Metal Ducts."

2.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.

- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. **Mark all final settings.**
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

2.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Single Zone Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Balance systems similar to constant-volume air systems.
 2. Set air inlets, air outlets, and supply fan at full-airflow condition.
 3. Adjust air outlets to indicated airflow.
 4. Readjust fan airflow for final maximum readings.
 5. Measure operating static pressure at the sensor that controls the supply fan and verify operation of the static-pressure controller.
 6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 7. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
- B. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 2. Verify that the system is under static pressure control.
 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.

- c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
- 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
- 6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
- 7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
- 8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
- 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. **Mark final settings.**

- e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
- f. Verify tracking between supply and return fans.

2.8 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

2.9 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

2.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering- and leaving-water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
- 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.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

2.11 TOLERANCES

A. Set HVAC system's flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

2.12 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

2.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Equipment operating curves.
2. Pump curves.
3. Fan curves.
4. Manufacturers' test data.
5. Field test reports prepared by system and equipment installers.
6. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.

5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water flow rates.
 3. Water and steam flow rates.
 4. Duct, outlet, and inlet sizes.
 5. Pipe and valve sizes and locations.
 6. Terminal units.
 7. Balancing stations.
 8. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.

- i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - l. Variable frequency drive information.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Variable frequency drive information.
- F. Apparatus-Coil Test Reports:
- 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.

- e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
- G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.

- b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
 - f. Variable frequency drive setpoint.
- I. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.

- c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- L. Compressor and Condenser Reports: For refrigerant side of air-cooled condensing units, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Unit make and model number.
 - d. Compressor make.
 - e. Compressor model and serial numbers.
 - f. Refrigerant weight in lb.
 - g. Low ambient temperature cutoff in deg F.
 - 2. Test Data (Indicated and Actual Values):
 - a. Inlet-duct static pressure in inches wg.
 - b. Outlet-duct static pressure in inches wg.
 - c. Entering-air, dry-bulb temperature in deg F.
 - d. Leaving-air, dry-bulb temperature in deg F.
 - e. Condenser entering-water temperature in deg F.
 - f. Condenser leaving-water temperature in deg F.
 - g. Condenser-water temperature differential in deg F.
 - h. Condenser entering-water pressure in feet of head or psig.
 - i. Condenser leaving-water pressure in feet of head or psig.
 - j. Condenser-water pressure differential in feet of head or psig.
 - k. Control settings.

- l. Unloader set points.
- m. Low-pressure-cutout set point in psig.
- n. High-pressure-cutout set point in psig.
- o. Suction pressure in psig.
- p. Suction temperature in deg F.
- q. Condenser refrigerant pressure in psig.
- r. Condenser refrigerant temperature in deg F.
- s. Oil pressure in psig.
- t. Oil temperature in deg F.
- u. Voltage at each connection.
- v. Amperage for each phase.
- w. Kilowatt input.
- x. Crankcase heater kilowatt.
- y. Number of fans.
- z. Condenser fan rpm.
- aa. Condenser fan airflow rate in cfm.
- bb. Condenser fan motor make, frame size, rpm, and horsepower.
- cc. Condenser fan motor voltage at each connection.
- dd. Condenser fan motor amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

2.14 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Engineer and commissioning authority.
- B. Engineer and commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

**PROJECT NO. 23-612.00
KPS LOY NORRIX HIGH SCHOOL HEALTH SUITE
KALAMAZOO PUBLIC SCHOOLS**

**TESTING, ADJUSTING, AND BALANCING FOR HVAC
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2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

END OF SECTION 23 0593

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SECTION 23 0700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulation materials for HVAC systems.
- B. Related Sections:
 - 1. Division 22 Section "Plumbing Insulation."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated below:
 - 1. Mineral fiber.
 - 2. Flexible elastomeric.
 - 3. Field installed jackets
- B. Shop Drawings:
- C. Field quality-control reports.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program.
- B. 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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application.
 - 1. Establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- G. Flexible Elastomeric with Factory Applied Jacket: Closed-cell, sponge- or expanded-rubber materials with laminated membrane on exterior surface, and with or without pressure sensitive adhesive. Comply with ASTM C 534, Type II for sheet materials.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- J. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
- K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Provide ASJ for equipment applications.
 - 2. Provide ASJ or FSK for ductwork applications, as scheduled.
 - 3.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 200 deg F.
 - 3. Solids Content: 63 percent by volume and 73 percent by weight.
 - 4. Color: White.

2.5 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
 - 5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 6. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 - f. Vimasco Corporation; 750.
 - g.
 - 7. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 8. Permanently flexible, elastomeric sealant.
 - 9. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 10. Color: White or gray.
 - 11. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK Jacket Flashing Sealants:
 - 1. Products:
 - a. Childers Products, Division of ITW; CP-76-8.

- b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: White.
 5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. PVDC Jacket for Indoor Applications:
 6. PVDC Jacket for Outdoor Applications
 7. PVDC-SSL Jacket:

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.
 - 4. Factory-fabricated tank heads and tank side panels.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - 1. Factory cut and rolled to size or sheet and roll stock ready for shop or field sizing.
 - 2. Finish and thickness are indicated in field-applied jacket schedules.
 - 3. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
 - 4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - 5. Factory-Fabricated Fitting Covers:
 - a. Same material, finish, and thickness as jacket.
 - b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: Minimum 40-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.
 - 1. Coordinate color of optional colors with Architect and Owner.
 - 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Polyguard; Alumaguard.
 - b. MFM Building Products; Flex Clad 400
- F. PVDC Jacket for Indoor Applications:
- G. PVDC Jacket for Outdoor Applications
- H. PVDC-SSL Jacket

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.

2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications:
- F. PVDC Tape for Outdoor Applications:

2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch or 3/4 inch wide with wing or closed seal.
- B. Insulation Pins and Hangers:
1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, aluminum, or stainless steel; fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

- c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, aluminum, or stainless steel; fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
 4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel, aluminum, or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

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.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. 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.
- Q. 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. Tank Manholes.
 6. Tank Handholes.
 7. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations:
- B. 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 at roof structure and seal with joint sealant.
 3. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant.
 4. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 5. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 6. Seal jacket to roof flashing with flashing sealant.
- C. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- D. 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.
 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 outside wall flashing and overlap wall flashing at least 2 inches.
 5. Seal jacket to wall flashing with flashing sealant.
- E. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For mineral fiber insulation, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 10. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
- E. Insulation Installation on Control Valves:
 - 1. Omit insulation over control valves.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - 1. Flexible elastomeric pipe insulation only allowed in concealed or mechanical room locations.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install 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.

D. 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.

3.7 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 o.c.
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 Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. **OLD STANDARD DO NOT USE** 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 fitting 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.
2. Fill inside of fitting jackets to prevent collapse of jacket.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

A. Paintable Jacket Material: Paint jacket with paint system identified in Division 09 painting Sections.

1. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
2. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
3. Do not field paint aluminum or stainless-steel jackets.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation: Insulate the following in accordance with insulation schedule:

1. Supply air.
2. Outdoor air.
3. Return air.
4. Relief air.
5. Duct mounted reheat coils.
6. Slot and linear diffuser plenums.
7. Outdoor air to horizontal unit ventilators.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.

2. Factory-insulated plenums and casings, except as indicated.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.
6. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
7. Exposed return metal ducts within rooms they are serving except mechanical rooms.
8. Exposed supply metal ducts within rooms they are serving down stream of duct mounted coils and VAV terminal units except mechanical rooms.
9. Fibrous-glass ducts.
10. Volume control balancing damper lever handles.

C. Definitions:

1. Concealed: Above solid ceiling and not visible from below.
2. Exposed: In rooms with no ceilings or with partial ceilings (i.e. "cloud type ceilings") and visible from below.
3. Finished Spaces: Spaces with room finishes accessible by building occupants.
4. Unfinished Spaces: Spaces with no or limited room finishes accessible by building maintenance and support staff only.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable insulation materials and thicknesses are identified for each piping system and pipe size range.
1. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Control valve stem and actuator.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F(16 Deg C):
1. All Pipe Sizes Exposed in Mechanical Rooms and Concealed Locations: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch(25 mm) thick.
 - b. Flexible Elastomeric: 1 inch(25 mm) thick.
 2. All Pipe Sizes Exposed in Finished Spaces: Insulation shall be following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch(25 mm) thick.
- B. Refrigerant Suction and Hot-Gas Piping: Insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
 2. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping: Insulation shall be one of the following:

1. Flexible Elastomeric: 2 inches thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

1. If more than one material is listed, selection from materials listed is Contractor's option.

B. Pipe Fittings with Mineral Fiber Insulation:

1. PVC Fitting Covers: 20 mils thick, white.

C. Exposed Vertical Piping within 8 feet of Floor shall be one of the following:

1. PVC: 30 mils thick, white.
2. Aluminum, Smooth or Stucco Embossed: 0.024 inch thick.

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.

1. If more than one material is listed, selection from materials listed is Contractor's option.

B. Piping:

1. Cover flexible elastomeric insulation with one of the following:
 - a. Adhere 10 x 10 woven mesh using insulation manufacturer's recommended adhesive and finish with two coats of manufacturer's recommended finish.
 - b. Aluminum, Smooth or Stucco Embossed: 0.024 inch thick.
2. Cover mineral fiber insulation with one of the following:
 - a. Self-adhesive outdoor jacket with aluminum foil facing.
 - b. Aluminum, Smooth or Stucco Embossed: 0.024 inch thick.

END OF SECTION 23 0700

SECTION 23 0800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.
 - 2. Division 22 Section "Commissioning of Plumbing" for plumbing commissioning requirements.
 - 3. Division 26 Section "Commissioning of Electrical Systems" for electrical systems commissioning requirements.

1.2 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA as defined in the Commissioning Plan.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- G. Provide training to Owner's personnel on system operations, preventive maintenance, sequence of operations, and general function on systems.

1.4 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.5 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

1.6 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

- C. 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.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing agency 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing agency shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. 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.
- C. 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.
- D. The CxA along with the HVAC&R Installer, testing and balancing agency, and HVAC&R Instrumentation and Control Installer shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

- E. Tests will be performed using design conditions whenever possible.
- F. 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.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. 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.
- I. 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 Construction Manager CxA Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Installer shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of hot-water 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.
- E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other

refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

- F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 23 0800

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SECTION 23 0900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Work shall include furnishing all labor, materials, equipment, and service necessary for a complete and operating Building Management System (BMS), utilizing direct digital controls. The BMS shall be capable of total integration of the facility infrastructure systems with user access to all system data either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet. This shall include HVAC control, electrical, gas and water metering, energy management, alarm monitoring, security and personnel access control, fire-life safety system monitoring, and all trending, reporting and maintenance management functions related to normal building operations all as indicated.
1. New Work shall communicate with and be integrated into Owner's existing district wide DDC control system.
 2. All labor, material, equipment and software not specifically referred to herein or on the plans, required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.
 3. The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.
 4. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet and MODBUS.
 5. System architecture shall provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.
 6. Any control vendor that shall provide additional BMS server software shall be unacceptable. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section.
 7. The BMS server shall host all graphic files for the control system. All graphics and navigation schemes for this project shall match those that are on the existing campus Niagara 4 Framework server.
 8. Graphics, banner, functionality, navigation, data points, trends, and, etc. shall match the District's Template.
 9. Owner shall receive all Administrator level login and passwords for engineering toolset prior to the final 10% of the project payment. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.
 10. OPEN NIC STATEMENTS - All Niagara 4 software licenses shall have the following NiCS set to ALL: "accept.station.in=*"; "accept.station.out=*"; "accept.wb.in=*"; "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications.
 11. All JACE hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted "safe boot" technology.
 12. All JACE (SNC) and Station PASS PHRASES and PASSWORDS will be provided to the Owner or their representative at 90% completion or prior to retention being paid.
 13. To ensure quality, only JACE/WEBs 8000 hardware products will be used on this project.

- B. All products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided on request, with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
1. Federal Communications Commission (FCC), Rules and Regulations, Volume II -July 1986 Part 15 Class A Radio Frequency Devices.
 2. FCC, Part 15, Subpart B, Class B
 3. FCC, Part 15, Subpart C
 4. FCC, Part 15, Subpart J, Class A Computing Devices.
 5. UL 504 - Industrial Control Equipment.
 6. UL 506 - Specialty Transformers.
 7. UL 910 - Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces.
 8. UL 916 - Energy Management Systems All.
 9. UL 1449 - Transient Voltage Suppression.
 10. Standard Test for Flame Propagation Height of Electrical and Optical - Fiber Cables Installed Vertically in Shafts.
 11. EIA/ANSI 232-E - Interface Between Data Technical Equipment and Data Circuit Terminal Equipment Employing Serial Binary Data Interchange.
 12. EIA 455 - Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
 13. IEEE C62.41- Surge Voltages in Low-Voltage AC Power Circuits.
 14. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - a. NEMA 250 - Enclosures for Electrical Equipment.
 15. NEMA ICS 1 - Industrial Controls and Systems.
 16. NEMA ST 1 - Specialty Transformers.
 17. NCSBC Compliance, Energy: Performance of control system shall meet or surpass the requirements of ASHRAE/IESNA 90.1-1999.
 18. CE 61326
 19. C-Tick
 20. cUL
- C. Work shall include but not limited to providing controls and instrumentation in accordance with equipment sequence of operations and their point lists. Point lists shall be a guide to the points required for control system. Final points required shall be determined by sequence of operation requirements.
- D. Work required in this section shall include the complete Building Management System (BMS) including all controllers Interoperable LonWorks Controllers (ILC), Interoperable BACnet Controllers (IBC), control devices, control panels, controller programming, controller programming software, controller input/output wiring, power wiring, interlock and safety wiring, graphical user interface, Graphical User Interface (GUI), Graphical Development Tool (GDT), Network Area Controller(s) (NAC), server software, controller software and programming of the NAC and server, development of all graphical screens, setup of schedules, logs and alarms, global server software control applications, system integration and coordination of the NAC and server software to the Wide Area Network.
- E. Ethernet LAN wiring, and Ethernet routing devices if applicable. The BMS shall provide a single point Ethernet connection utilizing OBIX TCP/IP to the Owner's WAN.

- F. Work required in this section shall include providing all electrical work required for this section. The system shall include all interconnecting wiring and conduit as required for a fully operational system as specified. Wiring shall be installed as per local codes or Division 26 whichever is more stringent.
1. Power supply wiring and conduit from power source to power connection on DDC controls and DDC control panels.
 - a. Line voltage wiring shall utilize methods and materials complying with the requirements of the Electrical Specifications, local building code, and NEC.
 2. Control wiring and conduit between field-installed controls, indicating devices, and control panels.
 - a. Low voltage wiring shall use methods and materials complying with the requirements of the Electrical Specifications, local building code and NEC. Plenum rated cable is acceptable where concealed and accessible.

1.2 RELATED SECTIONS

- A. The following Sections contain requirements that relate to this Section:
1. Division 01 Section "Alternates" for requirements of alternates that relate to this Section.
 - a. Alternate No. 1 pertains to training the owner on the use of building controls.

1.3 WORK BY OTHERS

- A. Setting in place of control valves, flow meters, water pressure and differential taps, flow switches, thermal wells, control dampers, airflow stations, and access doors.
- B. Duct smoke detectors provide under Division 28.

1.4 SPECIFICATION NOMENCLATURE

- A. Acronyms used in this specification are as follows:
1. Actuator: Control device that opens or closes valve or damper in response to control signal.
 2. AI: Analog Input.
 3. AO: Analog Output.
 4. Analog: Continuously variable state over stated range of values.
 5. BMS: Building Management System.
 6. DDC: Direct Digital Control.
 7. Discrete: Binary or digital state.
 8. DI: Discrete Input.
 9. DO: Discrete Output.
 10. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
 11. FO: Fail open (position of control device or actuator). Device moves to open position on loss of control signal or energy source.
 12. GUI: Graphical User Interface.

13. HVAC: Heating, Ventilating and Air Conditioning.
14. IDC: Interoperable Digital Controller.
15. ILC: Interoperable Lon Controller.
16. LAN: Local Area Network.
17. Modulating: Movement of a control device through an entire range of values, proportional to an infinitely variable input value.
18. Motorized: Control device with actuator.
19. NAC: Network Area Controller.
20. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
21. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
22. OSS: Operating System Server, host for system graphics, alarms, trends, etc.
23. Operator: Same as actuator.
24. PC: Personal Computer.
25. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
26. P: Proportional control; control mode with continuous linear relationship between observed input signal and final controlled output element.
27. PI: Proportional-Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controller variable (reset control).
28. PICS: BACnet Product Interoperability Compliance Statement.
29. PID: Proportional-Integral-Derivative control, control mode with continuous correction of final controller output element versus input signal based on proportional error, its time history (reset) and rate at which it's changing (derivative).
30. Point: Analog or discrete instrument with addressable database value.
31. WAN: Wide Area Network.

1.5 ACTION SUBMITTALS

- A. Refer to Division 1 for submittal administrative requirements and procedures.
- B. Submittal shall consist of:
 1. System architecture showing all digital devices, computers and network configuration.
 2. Equipment lists of all proposed devices and equipment including data sheets of all products. Provide a PIC statement for each BACnet device and interoperability certification for each LonMark field device provided.
 3. Valve, damper, and well and tap schedules showing size, configuration, capacity and location of all equipment.
 4. Data entry forms for initial parameters. Contractor shall provide English listing of all analog points with columnar blanks for high and low warning limits and high and low alarm limits, and a listing of all systems with columnar blanks for beginning and end of occupancy periods; and samples of proposed text for points and messages (for at least two systems of at least 15 points total) including sample 480 character alarm message. All text shall be approved prior to data entry.
 5. Schematic device wiring and piping interconnection diagrams including panel and device power and sources.

6. Software design data including flowchart of a typical DDC program showing interrelationship between inputs, PID functions, all other functions, outputs, etc.
7. A complete written Sequence of Operation in suppliers own terminology.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data for control systems equipment to include in the operation and maintenance manual specified in Division 1. Include the following:
 1. Maintenance instructions and spare parts lists for each type of control device.
 2. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 3. Calibration records and list of set points.
- B. Project Record Documents: Upon completion of the work, provide a complete set of 'as-built' drawings and application software on USB drive media or compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Three copies of the 'as-built' drawings shall be provided in addition to the documents on USB drive media or compact disk.

1.7 CODES AND APPROVALS

- A. The complete BMS installation shall be in strict compliance to the national, state and local mechanical and electrical codes and the electrical section of these specifications. All devices shall be UL or FM listed and labeled for the specific use, application and environment to which they are applied.
- B. The system shall comply with NFPA 90A Air Conditioning and 90B Warm Air Heating, Air conditioning.
- C. System shall be designed and manufactured to ISO 9001 quality standard, and all electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

1.8 WARRANTY

- A. All components, system software, and parts supplied by the BMS contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date. The BMS contractor at no charge shall furnish labor to repair, reprogram, or replace components during the warranty period. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the Owners request for warranty service within 48 hours during normal business hours.
- B. Warranty Access
 1. The Owner shall grant to the controls installer reasonable access to the BMS during the warranty period.

1.9 BMS CONTRACTOR QUALIFICATIONS

- A. The BMS contractor shall have a local office within a 75 mile(120 Km)radius of the job site, staffed with and NiagaraN4 Certified factory trained engineers fully capable of providing instruction, routine

maintenance and 24-hour emergency service on all system components. The BMS contractor shall have a three year experience record in the design and installation of computerized building systems similar in scope and performance to that specified herein, and shall be prepared to provide evidence of this history as condition of acceptance and approval during Submittal.

1. This office will employ at least four NiagaraN4 programmers.
2. This office will be established as a Honeywell Authorized Controls Integrator - ACI

- B. Single Source Responsibility of Supplier: The Control System Contractor shall be responsible for the complete installation and proper operation of the control system. The Control System Contractor shall exclusively be in the regular and customary business of design, installation and service of computerized building management systems similar in size and complexity to the system specified. The Control System Contractor shall be the manufacturer of the primary DDC system components or shall have been the authorized representative for the primary DDC components manufacturer for at least 5 years.
- C. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in the production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

1.10 SOFTWARE LICENSE AGREEMENT

- A. Software licensing for the Network Area Controller (NAC) and server software shall give the Owner the capability to control their system and determine which contractors can bid and engineer their system.
- B. It shall be possible to insure the Owner can prevent unauthorized partners from accessing the system for engineering changes.
- C. Software licensing shall have the freedom to individually manage authorized parties and independent parties.
- D. The Owner shall accept the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

1.11 ADDED POINT AND MEMORY CAPACITY

- A. The BMS software/firmware provided shall have the capacity for an unlimited number of NACs. Systems requiring future upgrades to accomplish this are not acceptable; capacity shall be provided at the time of bid.
- B. Total system point capacity shall have the capacity for an unlimited number of future points. Systems requiring future upgrades to accomplish this are not acceptable; capacity shall be provided at the time of bid.
- C. Supervising software shall allow unlimited expansion. Supervising software that is limited to the number of network area controllers is not acceptable

1.12 BMS TESTING AND ADJUSTING

- A. Control Contractor shall be responsible for adjusting and readjusting the control systems as required to obtain the desired control sequencing and intent of the specifications. Refer to Section 23 0593 and requirement that system balance be accomplished twice.
- B. If proper sequencing or system functions cannot be achieved with the factory provided controls, as specified and installed by the equipment manufacturer, and additional controls are required, the required additional controls shall be added at the expense of the factory controls provider.

1.13 DELIVERY, STORAGE, AND PROTECTION

- A. Store equipment and materials inside and protected from weather.

1.14 COORDINATION

- A. Coordinate location of exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- D. Pre-Installation Conference: Attend a temperature controls conference with the project engineer to develop a mutual understanding of the sequencing, components, and details required for the project.
 - 1. Engineer may invite other controls related stakeholders to this conference.
 - 2. Provide a minimum of 7 days' advance notice of scheduled meeting time and location.

1.15 PROJECT COMMISSIONING

- A. Project has an independent commissioning authority (CxA). Contractors for this project shall meet CxA requirements and shall coordinate with and participate in commissioning activities.

PART 2 - PRODUCTS

2.1 INSTALLERS

- A. Subject to compliance with requirements, provide installation, products and services by one of the following:
 - 1. ControlNet LLC.
 - 2. Havel Brothers.

2.2 GENERAL

- A. The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, Network Area Controllers, server software server, graphical user interface software, Web Browser Clients, portable operator terminals, printers, network devices and other devices as specified herein.
- B. Provide the capability to open all control valves in each individual system at one time (I.E. zone, riser) to facilitate water balancing.

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate SNMP, LonWorks, BACnet IP, BACnet MSTP, Modbus TCP/IP or Modbus RTU communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet. For each Modbus device supplier must provide a Registry of data points available on the system.
- C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
- D. The supplied system must incorporate the ability to access all data using standard web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
- E. The installed system shall provide secure password access to all features, functions and data contained in the overall BMS. Secure Socket Layer (SSL) encryption shall be an available option for remote access.
- F. The installed system must be totally scalable to allow for future expansion with the addition of controllers and/or input/output devices. It shall not be necessary to remove equipment supplied under this contract to expand the system.
- G. The failure of any single component or network shall not interrupt the control functions of non-affected devices. A single network failure shall only affect shared communications or shared data; individual application controllers and network controllers shall continue normal operation minus only the data from a remote device from the affected network. Automatic default values for all network transported data shall be provided to allow continued operation until the network is restored.

- H. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
 - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.4 SYSTEM NETWORK CONTROLLER (SNC)

- A. These controllers are designed to manage communications between the programmable equipment controllers (PEC), application specific controllers (ASC) and advanced unitary controllers (AUC) which are connected to its communications trunks, manage communications between itself and other system network controllers (SNC) and with any operator workstations (OWS) that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.
- B. The controllers shall be fully programmable to meet the unique requirements of the facility it shall control.
- C. The controllers shall be capable of peer-to-peer communications with other SNC's and with any OWS connected to the BAS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.
- D. The communication protocols utilized for peer-to-peer communications between SNC's will be Niagara 4 Fox, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between SNC's is not allowed.
- E. The SNC shall employ a device count capacity license model that supports expansion capabilities.
- F. The SNC shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:
 - 1. BACnet
 - 2. Lon
 - 3. MODBUS
 - 4. SNMP
 - 5. KNX
- G. The SNC shall be capable of executing application control programs to provide:
 - 1. Calendar functions.
 - 2. Scheduling.
 - 3. Trending.
 - 4. Alarm monitoring and routing.
 - 5. Time synchronization.
 - 6. Integration of LonWorks, BACnet, and MODBUS controller data.
 - 7. Network management functions for all SNC, PEC and ASC based devices.
- H. The SNC shall provide the following hardware features as a minimum:

1. Two 10/100 Mbps Ethernet ports.
 2. Two Isolated RS-485 ports with biasing switches.
 3. 1 GB RAM
 4. 4 GB Flash Total Storage / 2 GB User Storage
 5. Wi-Fi (Client or WAP)
 6. USB Flash Drive
 7. High Speed Field Bus Expansion
 8. -20-60°C Ambient Operating Temperature
 9. Integrated 24 VAC/DC Global Power Supply
 10. MicroSD Memory Card Employing Encrypted Safe Boot Technology
- I. The SNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- J. The SNC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.
- K. The SNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
 - a. Alarm.
 - b. Return to normal.
 - c. To default.
 2. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text.
 - b. Email of complete alarm message to multiple recipients.
 - c. Pagers via paging services that initiate a page on receipt of email message.
 - d. Graphics with flashing alarm object(s).
 3. The following shall be recorded by the SNC for each alarm (at a minimum):
 - a. Time and date.
 - b. Equipment (air handler #, access way, etc.).
 - c. Acknowledge time, date, and user who issued acknowledgement.
- L. Programming software and all controller "Setup Wizards" shall be embedded into the SNC.
1. The SNC shall support the following security functions.
 2. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
 3. Role-Based Access Control (RBAC) for managing user roles and permissions.
 4. Require users to use strong credentials.
 5. Data in Motion and Sensitive Data at Rest be encrypted.
 6. LDAP and Kerberos integration of access management.
- M. The SNC shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
1. Metadata: Descriptive tags to define the structure of properties.

2. Tagging: Process to apply metadata to components
3. Tag Dictionary

- N. The SNC shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (PEC, AUC, AVAV, VFD...) shall have an associated template file for reuse on future project additions.
- O. The SNC shall be provided with a 5 Year Software Maintenance license. Labor to implement is to be included.
- P. In order to ensure future serviceability it is the intent of this specification that the local control contractor provide all programmable microprocessor based controls for all HVAC equipment with the exception of controls that are internal to the operation of equipment, i.e. Chiller control and Boiler combustion control. It is acceptable if the equipment supplier has a DDC ready package available to include dampers, valves, actuators, sensors, relays and safeties, transformer etc. Any equipment provided devices from the factory must match those specified herein and be coordinated with the control contractor to ensure power and signal compatibility are met.

2.5 PROGRAMMABLE EQUIPMENT CONTROLLER (PEC)

- A. HVAC control shall be accomplished using LonMark or BACnet based devices where the application has a LonMark profile or BTL Listed PICS defined. Where LonMark devices are not available for a particular application, devices based on LonWorks shall be acceptable. For each LonWorks device that does not have LonMark certification, the device supplier shall provide an XIF file for the device. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".
- B. All PECs shall be application programmable and shall at all times maintain their certification. All control sequences within or programmed into the PEC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
- C. The following integral and remote Inputs/Outputs shall be supported per each PEC:
1. Eight integral dry contact digital inputs.
 2. Any two digital inputs may be configured as pulse counters with a maximum pulse read rate of 15 Hz.
 3. Eight integral analog inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC).
 4. Six integral 4-20 ma and/or 0-10 vdc analog outputs.
 5. Eight integral 24 Vac Triac digital outputs, configurable as maintained or floating motor control outputs.
 6. One integral 20 Vdc, 65-mA power supply for auxiliary devices.
 7. If a 20 Vdc 65-mA power supply terminal is not integral to the PEC, provide at each PEC a separate, fully isolated, enclosed, current limited and regulated UL listed auxiliary power supply for power to auxiliary devices.
- D. Each PEC shall have expansion ability to support additional I/O requirements through the use of remote input/output modules.

E. PEC Controllers shall support at minimum the following control techniques:

1. General-purpose control loops that can incorporate Demand Limit Control strategies, Set point reset, adaptive intelligent recovery, and time of day bypass.
2. General-purpose, non-linear control loops.
3. Start/stop Loops.
4. If/Then/Else logic loops.
5. Math Function loops (MIN, MAX, AVG, SUM, SUB, SQRT, MUL, DIV, ENTHALPY).

2.6 ADVANCED UNITARY CONTROLLER (AUC)

A. The advanced unitary controller (AUC) platform shall be designed specifically to control HVAC - ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes: constant volume air handlers, VAV air handlers, packaged RTU, heat pumps, unit vents, fan coils, natural convection units and radiant panels. The control shall use LonMark or BACnet based devices where the application has a LonMark profile or BTL Listed PICS defined. Where LonMark devices are not available for a particular application, devices based on LonWorks shall be acceptable. For each LonWorks device that does not have LonMark certification, the device supplier shall provide an XIF file for the device. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

B. Minimum Requirements:

1. The controller shall be fully programmable with full functionality on any Niagara 4 brand platform.
 - a. Support downloads to the controller from any brand of Niagara 4 platform.
 - b. Support uploads from the controller to any brand of Niagara 4 platform.
 - c. Support simulation/debug mode of the controller.
 - d. Maintain native GUI.
2. The controller shall be capable of either integrating with other devices or stand-alone operation.
3. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications. Controller memory minimum requirements include:
 - a. FLASH Memory Capacity: 116 Kilobytes with 8 Kilobytes for application program.
 - b. FLASH Memory settings retained for ten years.
 - c. RAM: 8 Kilobytes.
4. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
 - a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
 - b. Accuracy: ± 1 minute per month at 77 degrees F (25 degrees C).
 - c. Power Failure Backup: 24 hours at 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
5. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
6. The controller shall have an internal DC power supply to power external sensors.

- a. Power Output: 20 VDC \pm 10% at 75 mA.
7. The controller shall have a visual indication (LED) of the status of the device:
 - a. Controller operating normally.
 - b. Controller in process of download.
 - c. Controller in manual mode under control of software tool.
 - d. Controller lost its configuration.
 - e. No power to controller, low voltage, or controller damage.
 - f. Processor and/or controller are not operating.
8. The minimum controller Environmental ratings.
 - a. Operating Temperature Ambient Rating: -40 degrees to 150 degrees F (-40 degrees to 65.5 degrees C).
 - b. Storage Temperature Ambient Rating: -40 degrees to 150 degrees F (-40 degrees to 65.5 degrees C).
 - c. Relative Humidity: 5% to 95% non-condensing.
9. The controller shall have the additional approval requirements, listings, and approvals:
 - a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
 - b. CSA (LR95329-3) Listed.
 - c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
 - d. Meets Canadian standard C108.8 (radiated emissions).
 - e. Conforms requirements European Consortium standard EN 61000-6-1; 2001 (EU Immunity).
 - f. Conforms requirements European Consortium standard EN 61000-6-3; 2001 (EU Emission).
10. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
11. The controller shall have a mix of digital inputs (DI), digital Triac outputs (DO), analog outputs (AO), and universal inputs (UI).
 - a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
 - b. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
 - c. Input and Output wiring terminals shall be designated with color coded labels.
 - d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).
12. The controller shall provide "continuous" automated loop tuning with an Adaptive Integral Algorithm Control Loop.
13. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined on the Drawings.

2.7 ADVANCED VARIABLE AIR VOLUME CONTROLLER (AVAV)

- A. The advanced VAV controller platform shall be designed specifically for room-level VAV control - pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO₂, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, Series fan powered terminal

unit, Parallel fan powered terminal unit, Supply and Exhaust air volume terminals and Constant volume dual-duct terminal unit. Control shall be accomplished using LonMark or BACnet based devices where the application has a LonMark profile or BTL Listed PICS defined. Where LonMark devices are not available for a particular application, devices based on LonWorks shall be acceptable. For each LonWorks device that does not have LonMark certification, the device supplier shall provide an XIF file for the device. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

B. Minimum Requirements:

1. The controller shall be fully programmable with full functionality on any Niagara 4 brand platform.
 - a. Support downloads to the controller from any brand of Niagara 4 platform.
 - b. Support uploads from the controller to any brand of Niagara 4 platform.
 - c. Support simulation/debug mode of the controller.
 - d. Maintain native GUI.
2. The controller shall be capable of either integrating with other devices or stand-alone room-level control operation.
3. The controller shall have an internal velocity pressure sensor.
 - a. Sensor Type: Microbridge air flow sensor with dual integral restrictors.
 - b. Operating Range: 0 to 1.5 inch H₂O (0 to 374 Pa).
 - c. Accuracy: $\pm 2\%$ of full scale at 32 degrees to 122 degrees F (0 degrees to 50 degrees C); $\pm 1\%$ of full scale at null pressure.
4. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications.
 - a. FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
 - b. FLASH Memory settings retained for ten years.
 - c. RAM: 2 Kilobytes.
5. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
 - a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
 - b. Accuracy: ± 1 minute per month at 77 degrees F (25 degrees C).
 - c. Power Failure Backup: 24 hours at 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
6. The controller shall have Significant Event Notification, Periodic Update capability and Failure Detect when network inputs fail to be detected within their configurable time frame.
7. The controller shall have an internal DC power supply to power external sensors.
 - a. Power Output: 20 VDC $\pm 10\%$ at 75 mA.
8. The controller shall have a visual indication (LED) of the status of the device:
 - a. Controller operating normally.
 - b. Controller in process of download.
 - c. Controller in manual mode under control of software tool.
 - d. Controller lost its configuration.

- e. No power to controller, low voltage, or controller damage.
 - f. Processor and/or controller are not operating.
9. The minimum controller Environmental ratings:
- a. Operating Temperature Ambient Rating: 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
 - b. Storage Temperature Ambient Rating: 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
 - c. Relative Humidity: 5% to 95% non-condensing.
10. The controller shall have the additional approval requirements, listings, and approvals:
- a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
 - b. CSA (LR95329-3) Listed.
 - c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
 - d. Meets Canadian standard C108.8 (radiated emissions).
 - e. Conforms requirements European Consortium standard EN 61000-6-1; 2001 (EU Immunity).
 - f. Conforms requirements European Consortium standard EN 61000-6-3; 2001 (EU Emission).
11. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
12. The controller shall provide an integrated actuator option.
- a. Actuator type: Series Floating.
 - b. Rotation stroke: 95 degrees \pm 3 degrees for CW or CCW opening dampers.
 - c. Torque rating: 44 lb-inch (5 Nm).
 - d. Run time for 90 degrees rotation: 90 seconds at 60 Hz.
13. The controller shall have digital inputs (DI), digital Triac outputs (DO), three analog outputs (AO), and universal inputs (UI).
- a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
 - b. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
 - c. Input and Output wiring terminals shall be designated with color coded labels.
14. The controller shall provide "continuous" automated loop tuning with an Adaptive Integral Algorithm Control Loop.
15. The controller shall have a loop execution response time of 1 second.
16. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined on the Drawings.
- a. VAV terminal unit.
 - b. VAV terminal unit fan speed control.
 - c. Series fan.
 - d. Parallel fan.
 - e. Regulated air volume (room pressurization/de-pressurization).
 - f. CV dual-duct.
 - g. Room CO2 control.
 - h. Room Humidity.
 - i. TOD occupancy sensor stand-by set points.

2.8 NETWORKS

- A. The Local Area Network (LAN) shall be a 100 Megabits/sec Ethernet network supporting TCP/IP, BACnet IP, Modbus, Java, XML, and HTTP for maximum flexibility for integration of building data with enterprise information systems
- B. Local area network minimum physical and media access requirements:
 - 1. Ethernet; IEEE standard 802.3
 - 2. Cable; 10 Base-T, UTP-8 wire, category 5E or 6
 - 3. Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

2.9 NETWORK ACCESS

- A. Owners WAN / LAN Access: Controls Installer must adhere to Owner's policy and requirements to obtain Owner's WAN access.

2.10 BAS SERVER & WEB BROWSER GUI - SYSTEM OVERVIEW

- A. The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
- B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Windows operating systems.
- C. The BAS server software shall support at least the following server platforms (Windows 7, 8.1, 10, Server 12). The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
- D. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:
 - 1. Trending.
 - 2. Scheduling.
 - 3. Electrical demand limiting.
 - 4. Duty Cycling.
 - 5. Downloading Memory to field devices.
 - 6. Real time 'live' Graphic Programs.
 - 7. Tree Navigation.
 - 8. Parameter change of properties.
 - 9. Set point adjustments.
 - 10. Alarm / event information.
 - 11. Configuration of operators.
 - 12. Execution of global commands.
 - 13. Add, delete, and modify graphics and displayed data.

- E. Software Components: All software shall be the most current version. All software components of the BAS system software shall be provided and installed as part of this project. BAS software components shall include:
 - 1. Server Software, Database and Web Browser Graphical User Interface.
 - 2. 5 Year Software Maintenance license. Labor to implement is to be included.
 - 3. Embedded System Configuration Utilities for future modifications to the system and controllers.
 - 4. Embedded Graphical Programming Tools.
 - 5. Embedded Direct Digital Control software.
- F. BAS Server Database: The BAS server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.
- G. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
- H. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.
- I. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol Secure (HTTPS).

2.11 WEB BROWSER GRAPHICAL USER INTERFACE

- A. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.
- B. Mobile Web Browser Navigation through Smart Phones and Tablets: In order to assure comprehensive mobile navigation with all major browsers, navigation shall be done through the use of a touch-friendly dynamic navigation bar. Right-click commands are not compatible with most mobile/touch devices, so all equipment commands shall utilize touch-compatible buttons. The contents of the dynamic navigation bar shall be customized to match the specific requirements of each building, while retaining the same general categories for consistency and ease of use.
- C. Critical Data Display: The dynamic navigation bar may also display a critical data summary
- D. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.
- E. Navigation:

1. The buttons of the dynamic navigation bar shall be adaptive, changing hyperlink connections relevant to each system type, allowing hyperlinks, specific to the selected system to be added as requested by the consulting engineer.
 2. The dynamic navigation bar at the top of each BMS page will be provided and have the following links/functions:
 3. Home: A link that takes the user to a main entry point of navigation at a building or district level.
 4. Main Systems Icons/Buttons: Links to general systems like HVAC, Lights, and Card Access are indicated by icon buttons. Links to major systems and equipment such Hydronic Systems or Air Handlers are listed in descriptive buttons.
 5. Floor Plans: Links to floor plan sections are shown as graphic outline keys with descriptive buttons. Visual indicators highlight the part of the building that is relevant to the user's navigation (i.e. the section in which the currently viewed VAV box resides). Equipment occupancy status, when applicable, shall be indicated on the floor plan by a color-coded avatar.
 6. Alarm Console: A table that shows all points that are in an alarm state and allowing users to silence or acknowledge alarms from the alarm console. The dynamic navigation bar will show the total number of unacknowledged alarms without having to go to the Alarm Console page.
 7. Schedules: An at-a-glance schedule page that shows equipment schedule periods. The at-a-glance page allows users to change occupancy times with a weekly or calendar scheduler with a single click.
 8. Information: A page with links to pertinent documents, including a BMS User's Guide. This page will provide legends/keys that define status colors and icons. This page will also serve as the landing page for links to the following feature pages, if they are not directly linkable from the dynamic navigation bar:
 - a. Weather: A page that shows current local weather conditions in a seven-day forecast.
 - b. Alarm History: A log of previous alarms that features sorting and time range filters.
 - c. Audit Log: A log of users who have accessed the BMS. It records changes made by users and features sorting and time range filters.
 - d. Chart Builder: A tool that allows charts to be made comparing historical data. It allows custom-built chart data to be exported as an Excel or .PDF file.
 - e. Override Summary: A table of all equipment with a manual override status.
 - f. User Configuration: A page that allows users to change log-in and profile information. Users with administrative rights may add or delete users to the BMS.
 - g. Custom Dashboard: A page with customizable charts and gauges which can be saved independently for each operator.
 - h. Email Configuration: A page that will allow administrators to set up email notification specifics for operators regarding alarms.
 - i. User Configuration: A page that will allow administrators to add, delete, and edit the properties of users for the BAS.
 9. Log-Out: Pressing this button will log the current user out of the BMS and return the browser to the log-in screen.
 10. Navigational Info Fields: This feature provides information to the user by displaying the building name, current page name, current page description, outside air temperature, current date, and current time. The current page description is editable by the user from the graphic.
- F. Graphics Pane: The Graphics Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:
1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point

- controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
2. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web browser. User shall have ability to save custom dashboards. See Section 2.13 below.
 3. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the dynamic navigation bar).
 4. Alarms: Shall be used to view alarm information geographically (using the dynamic navigation bar), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
 5. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
 6. Global Set Points page: This page is used to monitor and set global commands that affect multiple systems/equipment. (For example, all finned tube valves in the building would have a global minimum valve position set point and corresponding outside air temperature set point).
 7. Preventative Maintenance Schedules page: This page is used to set and track runtimes for mechanical equipment. Alerts shall be sent to the Alarm Console when the runtime reaches the allocated time to notify operators that preventative maintenance is required. These runtime limits should be operator adjustable.
 8. Logic - Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
- G. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:
1. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
 2. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. The room temperature label colors shall be updated dynamically as a zone's actual comfort condition changes to give an at-a-glance realization of temperatures to the operator.
 3. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
 4. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
 - a. Each piece of equipment monitored or controlled including each terminal unit.
 - b. Each building.
 - c. Each floor and zone controlled.
- H. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day 'Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention

would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment shall be indicated on the Schedules Page.

1. Schedules: Schedules shall comply with the LonWorks and BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
 - a. Types of schedule shall be Normal, Holiday or Override.
 - b. A specific date.
 - c. A range of dates.
 - d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
 - e. Wildcard (example, allow combinations like second Tuesday of every month).
 2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
 3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
 4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
 5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
 6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.
- I. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
 2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.

3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A 'network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
 - a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
 - b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
 - c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
 - d. Write Property: The write property reporting action updates a property value in a hardware module.
 - e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
 - f. Run External Program: The Run External Program reporting action launches specified program in response to an event.
- J. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
 1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
 2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.

3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
 4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
 5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.
 6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
- K. Security Access: Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:
1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of 'easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
 - a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
 - b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
 - c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.
 2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

2.12 GRAPHICAL PROGRAMMING

- A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.
- B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
- C. Graphic Sequence: The clarity of the graphic sequence shall be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a

manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.

- D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
 2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
 3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
 4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
 5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
 6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
 7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
 8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
 9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
 10. Live Graphical Programs: The Graphic Programming software shall support a 'live' mode, where all input/output data, calculated data and set points shall be displayed in a 'live' real-time mode.

2.13 LONWORKS NETWORK MANAGEMENT

- A. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
- B. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices and to view health and status counters within devices.
- C. These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.
- D. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times and within the control system shall not be accepted.

2.14 CUSTOM GRAPHICS - REQUIRED

A. Home Page

1. The building site overview shall provide a “mouse over” function to highlight the floor plan area to be accessed as a navigational aid. Room numbers and/or names will be included at the owner’s request. Critical data points, i.e. Outdoor Air Temperature, Outdoor Air Relative Humidity, Hot Water Supply Temperature, Chilled Water Supply Temperature or National Weather Service data will be continuously visible, in real time, within the HTML frame on all screens. Additional points may be added or deleted at the owner’s request without cost.

B. Floor Plans

1. Detailed floor plans shall be created with a vector drawing program accurately depicting the actual building layout to include all rooms, walls, and hallways. All space sensors shall be accurately placed in their actual locations and tagged with their real time space temperature and equipment each is associated with, i.e. 72.5°F/RTU-1, 74.2°/AHU-1, 73.4°/TU-1. Floor plans too large to be practically shown with data points will provide a “mouse over” function to highlight the floor plan area to be accessed. Room numbers and/or names will be included at the owner’s request.

C. Mechanical Systems

1. Detailed graphics for each mechanical system will include; AHUs, RTUs, CW Piping and Pumps, HW Piping and Pumps, TUs, and EFs as a minimum. Mechanical systems will include on-screen access to their respective set-points, trend logs and schedule. All time schedules will be setup as directed by the owner prior to final job turnover.
2. Detailed graphics for each mechanical system will include; AHUs, RTUs, HXs, CW Piping and Pumps, HW Piping and Pumps, HPs, TUs, and EFs as a minimum. Mechanical systems will include on-screen access to their respective set-points, trend logs and schedule. All time schedules will be setup as directed by the owner prior to final job turnover.
3. Dynamic trends of all data points shall be set up (specification will be followed as to actual number of trend points possible) prior to final job turnover. Each trend will be available directly on screen for quick trend access.
4. Data points will be shown for all relevant inputs and outputs and be positioned near the actual device. Analog and digital parameters will be able to be modified directly from the equipment screen.

D. Terminal Units

1. Terminal units such as cabinet heaters, unit heaters, VAV boxes will depict the actual configuration of the equipment controlled. Actual equipment configurations from manufacturers web sites and/or photos of installed equipment shall be used to ensure graphic depictions are as “near actual” as possible.
2. Terminal units such as heat pumps, fan coil units, unit ventilators, reheat coils, booster coils and VAV boxes will depict the actual configuration of the equipment controlled. Actual equipment configurations from manufacturers web sites and/or photos of installed equipment shall be used to ensure graphic depictions are as “near actual” as possible.

2.15 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser . Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacturer-specific browsers shall not be acceptable.
- B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BMS, shall not be acceptable.
- C. The Web browser client shall support at a minimum, the following functions:
 - 1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - 2. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - 3. Storage of the graphical screens shall be in the NAC or server software, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - 4. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 - 5. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - c. View logs and charts
 - d. View and acknowledge alarms
 - e. Setup and execute SQL queries on log and archive information
 - 6. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
 - 7. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.16 SERVER SOFTWARE FUNCTIONS AND HARDWARE

- A. The server software shall be provided. The server software shall support all TCP/IP connected to the control system router.
- B. The Network server software shall provide the following functions, at a minimum:
 - 1. Global Data Access: The server software shall provide complete access to distributed data defined anywhere in the system.
 - 2. Distributed Control: The server software shall provide the ability to execute global control strategies based on control and data objects in any control system in the network, local or remote.
 - 3. The server software shall include a master clock service for its subsystems and provide time synchronization for all control systems.
 - 4. The server software shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
 - 5. The server software shall provide scheduling for all control systems and their underlying field control devices.
 - 6. The server software shall provide demand limiting that operates across all control systems. The server software must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
 - 7. The server software shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to control systems. Systems not employing this prioritization shall not be accepted.
 - 8. Each control system supported by the server software shall have the ability to archive its log data, alarm data and database to the Network server software, automatically. Archiving options shall be user-defined including archive time and archive frequency.
 - 9. The server software shall provide central alarm management for all control systems supported by the server software. Alarm management shall include:
 - a. Routing of alarms to display, printer, email and pagers
 - b. View and acknowledge alarms
 - c. Query alarm logs based on user-defined parameters
 - 10. The server software shall provide central management of log data for all control systems supported by the server software. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
 - a. Viewing and printing log data
 - b. Exporting log data to other software applications
 - c. Query log data based on user-defined parameters
- C. Server software Hardware Requirements: supplied by
 - 1. The system integrator will be responsible for loading and testing the software on the PC.
 - 2. The system integrator will coordinate with the owner for testing and authorization.

2.17 OBJECT LIBRARIES

- A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
- D. All control objects shall conform to the control objects specified in the BACnet specification.
- E. The library shall include applications or objects for the following functions, at a minimum:
 - 1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
 - 2. Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
 - 3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
 - 4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
 - 5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
 - 6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse

order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

- F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.
1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.
 3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
 4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
 5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
 6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
 7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
 8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
 9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
 10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog

object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.

11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

- G. The object library shall include objects to support the integration of devices connected to the Network Area Controller or server software. At a minimum, provide the following as part of the standard library included with the programming software:

1. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.
2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file and documentation for the device to facilitate device integration.
3. For BACnet devices, provide the following objects at a minimum:
 - a. BACnet AI
 - b. BACnet AO
 - c. BACnet BI
 - d. BACnet BO
 - e. BACnet Device
4. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

2.18 DDE DEVICE INTEGRATION

1. The Network Area Controller shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Network Area Controller shall act as a DDE client to another software application that functions as a DDE server.
2. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the BMS. Objects provided shall include at a minimum:
 - a. DDE Generic AI Object
 - b. DDE Generic AO Object
 - c. DDE Generic BO Object
 - d. DDE Generic BI Object

2.19 OTHER CONTROL SYSTEM HARDWARE

- A. Ethernet Switches

1. 8 Port 10/100 MBPS Switch / Hub
2. Din Rail Mounted
3. LED communication indicators
4. Acceptable Manufacturers
 - a. Contemporary Controls
 - b. INTEL
 - c. Cisco Systems

B. Temperature Sensors and Transmitters

1. General Sensor & Transmitter Requirements

- a. Provide sensors and transmitters required as outlined in the input/output summary and sequence of operation, and as required to achieve the specified accuracy as specified herein.
- b. Temperature transmitters shall be equipped with individual zero and span adjustments. The zero and span adjustments shall be non-interactive to permit calibration without iterative operations. Provide a loop test signal to aid in sensor calibration.
- c. Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearities of the sensor and bridge and provide a true linear output signal.
- d. Temperature sensors shall be of the resistance type and shall be 10K or 20K Ohm Thermistor type.
 - 1) Thermistors are acceptable provided the mathematical relationship of a thermistor with respect to resistance and temperature with the thermistor fitting constraints is contained with the controllers operating software and the listed accuracy's can be obtained. Submit proof of the software mathematical equation and thermistor manufacturer fitting constants used in the thermistor mathematical/expressions. Thermistors shall be of the Thermistor (NTC) Type with a minimum of 50 ohm/°C. resistance change versus temperature to insure good resolution and accuracy. Thermistors shall be certified to be stable $\pm 0.13^{\circ}\text{C}$. over 5 years and $\pm 0.2^{\circ}\text{C}$. accurate and free from drift for 5 years.
- e. The following accuracy's are required and include errors associated with the sensor, lead wire and A to D conversion.
 - 1)

<u>Point Type</u>	<u>Accuracy</u>
Outside Air	+/-3%
Chilled/Hot Water	+/-1%
Room Temperature	+/-1%
Duct Temperature	+/-3%
 - 2) Sensors Used in Energy Water (BTU) or Process Calculations +/-1%
 - 3) Sensors used in energy or process calculations shall be accurate over the process temperature range. Submit a manufacturer's calibration report indicating that the calibration certification is traceable to the National Bureau of Standards (NBS) Calibration Report Nos. 209527/222173.

2. Thermowells

- a. When thermowells are required, the sensor and well shall be supplied as a complete assembly including well head and Greenfield fitting, except where wells are to be installed under separate contract.
 - b. Thermowells shall be pressure rated and constructed in accordance with the system working pressure
 - c. Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
 - d. Thermowells shall be constructed of the following materials:
 - 1) Hot Water; brass.
 - 2) Chilled Water; brass.
 - 3) Steam; 316 stainless steel.
3. Outside Air Sensors
 - a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
 - d. Solar load sensors shall be provided in locations shown. The use of a thermistor combined with a solar compensator is acceptable. Provide calibration charts as part of the O&M Manual.
4. Duct Type Sensors
 - a. Duct mount sensors shall mount in a hand box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A neoprene grommet (sealtite fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Duct sensors probe shall be constructed of 304 stainless steel.
 - c. For outdoor air duct applications, use a weatherproof mounting box with weatherproof cover and gasket.
5. Averaging Duct Type Sensors
 - a. Where called out on the drawings and points lists, provide averaging type duct sensors. Thermistor sensors are acceptable. The sensor shall be multi-point sensitive through the length of the temperature conducting tubing. The thermistors shall be configured in a series / parallel method which creates an end result of total average resistance equal to the same span as a standard thermistor.
 - b. Provide capillary supports at the sides of the duct to support the sensing element.
6. Acceptable Manufacturers
 - a. Honeywell
 - b. Johnson Controls
 - c. ACI
 - d. Bapi

C. Relative Humidity Sensors/Transmitters

1. The sensor shall be a solid state, resistance type relative humidity sensor of the Bulk Polymer Design. The sensor element shall be washable and shall resist surface contaminations.
2. Humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2 wire isolated loop powered, 4-20ma, 0-10.0 VDC linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy including lead loss and A to D conversion.
 - a. Room Type Sensor $\pm 2\%$ RH
 - b. Duct Type Sensor $\pm 2\%$ RH
4. Outside air relative humidity sensors shall be installed in a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealite fittings and stainless steel bushings.
5. Provide a single point humidity calibrator, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
6. Duct type sensing probes shall be constructed of 304 stainless steel and be equipped with a neoprene grommet, bushings and a mounting bracket.
7. Acceptable Manufacturers:
 - a. Vaisala
 - b. ACI
 - c. Veris
 - d. Honeywell
 - e. Johnson Controls

D. Differential Pressure Transmitters and Accessories

1. General Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall provide the option to transmit a 0 to 5V dc, 0 to 10V dc, or 4 to 20 mA output signal.
 - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with shutoff and bleed valves in the high and low sensing pick-up lines (3 valve manifolds).
 - d. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.
 - e. Low air pressure, differential pressure transmitters used for room pressurization control (i.e. laboratories, OR's clean rooms, etc.) shall be equipped with a LED display indicating the transmitter output signal.
 - f. Duct sensing pressure applications where the velocity exceeds 1500 fpm shall utilize a static pressure traverse probes.
2. Low Air Pressure Applications (0 to 125 Pa)

- a. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signals with the following minimum performance specifications.
 - 1) Span: Not greater than two times the design space DP.
 - 2) Accuracy: Plus or minus 0.5% of F.S.
 - 3) Dead Band: Less than 0.3% of output.
 - 4) Repeatability: Within 0.2% of output.
 - 5) Linearity: Plus or minus 0.2% of span.
 - 6) Response: Less than one second for full span input.
 - 7) Temperature Stability: Less than 0.05% output shift per degree change.
 - b. The transmitter shall utilize variable capacitance sensor technology and be immune to shock and vibration.
 - c. Acceptable Manufacturers
 - 1) Auto Tran
 - 2) Veris
 - 3) Setra
3. Medium to High Air Pressure Applications (125 Pa to 2500 Pa)
- a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter except the performance specifications are not as severe. Provide differential pressure transmitters which meet the following performance requirements.
 - 1) Zero & span: (% F.S./Deg. C): .05% including linearity, hysteresis and repeatability
 - 2) Accuracy: 1% F.S. (best straight line)
 - 3) Static Pressure Effect: 0.5% F.S.
 - 4) Static Pressure Effect: 0.5% F.S. (to 700 KPa)
 - 5) Thermal Effects: $\leq \pm 0.05\%$ F.S. /Deg. C.
 - 6) Thermal Effects: $\leq \pm 0.05\%$ F.S. /Deg. C. over 5C. to 40C. (calibrated at 22°C.)
 - b. Acceptable manufacturers:
 - 1) Auto Tran
 - 2) Veris
 - 3) Setra
- E. Low Differential, Water Pressure Applications (0 KPa to 5 KPa)
1. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 2. The differential pressure transmitter shall have non-interactive zero and span adjustments adjustable from the outside cover and meet the following performance specifications.
 - a. 0 – 10 KPa input differential pressure range
 - b. 4 - 20 mA output
 - c. Maintain accuracy up to 20 to 1 ratio turndown
 - d. Reference Accuracy: $\pm 0.2\%$ of full span

3. Provide a two year warranty for each transmitter. Replace all transmitters found to be defective at no cost to the Owner during the warranty period. Acceptable Manufacturers:
 - a. Tobar
 - b. Veris
 - c. Foxboro
 - d. Omega
 - e. Bailey
 - f. Modus

F. Medium to High Differential Water Pressure Applications (5 KPa to 700 KPa)

1. The differential pressure transmitter shall meet the low pressure transmitter specifications except the following:
 - a. Differential pressure range 5 KPa to 700 KPa.
 - b. Reference Accuracy: $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability)
 - c. Warranty: 1 year.
2. Acceptable Manufacturers:
 - a. Auto Tran
 - b. Veris
 - c. ACI
 - d. Setra
3. Bypass Valve Assembly: Mount stand-alone pressure transmitters in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with hi and low connections piped and valved. Air bleed units, bypass valves and compression fittings shall be provided

G. Electronic Valve And Damper Actuators

1. General Requirements
 - a. Electronic actuators shall be electric, direct-coupled type capable of being mounted over the shaft of the damper. They shall be UL listed and the manufacturer shall provide a 2 year unconditional warranty from the date of commissioning. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts or 4 VA for VAV actuators. Sound level shall not exceed 45 dB for high torque or 35 dB for VAV actuators.
 - b. Electronic overload protection shall protect actuator motor from damage. If damper jams actuator shall not burn-out. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation to control signal as operation requires.
 - c. Warranty must be two years by manufacturer on actuator as a whole and all components.
 - d. Acceptable manufacturers:
 - 1) Honeywell
 - 2) Johnson Controls

3) Belimo

2. Control Damper Actuators

- a. OA (outside air), RA (return air), and EA (exhaust air) actuators shall be spring return type for safety functions. Individual battery backup, capacitor return is not acceptable.
- b. The control circuit shall be fully modulating using 2 - 10 volt or 4 - 20 mA signals. Accuracy and repeatability shall be within $\pm 1/21$ of control signal. A 2 - 10 v or 4 - 20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating damper position. Accuracy shall be within $\pm 2.5\%$.
- c. Face and bypass dampers and other control dampers shall be modulating using the same control circuit detailed above but shall not be spring return.

3. Miscellaneous Damper Actuators

- a. OA combustion and ventilation air intake and EA damper actuators shall be 2 position spring return closed if any water piping, coils or other equipment in the space which the damper serves needs to be protected from freezing. Otherwise drive open, drive closed type 2 position may be used.
- b. OA combustion and ventilation air intake and EA damper actuators shall be 2 position spring return closed if any water piping, coils or other equipment in the space which the damper serves needs to be protected from freezing. Otherwise drive open, drive closed type 2 position may be used. The minimum torque for any actuator shall be 5 N-m.
- c. Provide auxiliary switches on damper shaft or blade switch to prove damper has opened on all air handling equipment handling 100% outside air.
- d. Provide auxiliary switches on damper shaft or blade switch to prove damper has opened on all air handling equipment handling 100% outside air and greater than 6 KPa TSP.

4. Air Terminals

- a. Air terminal actuators shall use fully modulating floating (drive open, drive closed) 3 wire control or use control circuit as detailed in control dampers depending on the controllers' requirements.
- b. Air terminal actuators shall be minimum 5 N-m torque and use fully modulating floating (drive open, drive closed) 3 wire control or use control circuit as detailed in control dampers depending on the controllers' requirements.

5. Inlet Vanes Actuators

- a. Inlet vane actuators shall provide at least 150% of the minimum torque specified by the manufacturer as necessary to operate vanes properly. Either direct coupled or gear train with linkages are acceptable as required. The control loop for static control of the actuator shall operate slowly enough to avoid hunting and maintain stable control. See automation system specifications for details.

6. Combination Smoke and Fire Damper Actuators

- a. Actuators shall be factory mounted and connected to the damper section and shall conform to UL 555S specifications.

H. Valve Actuators

1. Control Valves Actuators (3 inch and smaller)

- a. Actuators shall have a gear release button on all non-spring return models to allow manual setting. The actuator shall have either an insulating air gap between it and the linkage or a non-conducting thermoplastic linkage. Care shall be taken to maintain the actuator's operating temperatures and humidity within its specifications. Pipes shall be fully insulated and heat shields shall be installed if necessary. Condensation may not form on actuators and shall be prevented by a combination of insulation, air gap, or other thermal break.
- b. The control circuit shall be fully modulating using 2 - 10 volt or 4 - 20 mA signals. Accuracy and repeatability shall be within 1/21 of control signal. A 2 - 10 v or 4 - 20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating valve position.
- c. Valve body and actuators shall be shipped fully assembled and tested at the valve factory prior to shipment.

2. Control Valve Actuators (4 inch and larger).

- a. The valve actuator shall consist of a permanent split capacitor, reversible type electric motor which drives a compound epicycle gear. The electric actuator shall have visual mechanical position indication, readable from a distance of 8 meters, showing output shaft and valve position. Unit shall be mounting directly to the valves without brackets and adapters, or readily adapted to suit all other types quarter-turn valves.
- b. The actuator shall have an integral terminal strip, which, through conduit entries, will ensure simple wiring to power supplies. Cable entries shall have UL recommended gland stops within the NPT hole to prevent glands from being screwed in too far and damaging cable.
- c. The actuator shall be constructed to withstand high shock and vibrations without operations failure. The actuator cover shall have captive bolts to eliminate loss of bolts when removing the cover from the base. One copy of the wiring diagram shall be provided with the actuator.
- d. The actuator shall have a self-locking gear train which is permanently lubricated at the factory. The gearing shall be run on ball and needle bearings. Actuators with 70 N-m or more output torque shall have two adjustable factory calibrated mechanical torque limit switches of the single-pole, double-throw type. The motor shall be fitted with thermal overload protection. Motor rotor shaft shall run in ball bearings at each end of motor.
- e. The actuator housing shall be hard anodized aluminum for full environmental protection.
- f. The environmental temperature range of the actuator shall be -22 to 140 deg F.
- g. For intermittent on/off service, the actuator shall be rated at a 20% duty cycle (i.e., 12 minutes extended duty in every hour, or alternatively; one complete cycle every 2 minutes). For more frequent cycling and modulating service, an actuator shall be rated for continuous duty. The actuator rated for continuous duty shall be capable of operating 100% of the time at an ambient temperature of 104 deg F.
- h. The actuator shall have an integral self-locking gear train. Motor brakes shall not be required to maintain desired valve position. Levers or latches shall not be required to engage or disengage the manual override. Mechanical travel stops, adjustable to 15° in each direction of 90° rotation shall be standard, as well as two adjustable travel limit switches with electrically isolated contacts. Additional adjustable switches shall be available as option.

- i. Single Phase Motor: The motor shall have Class B insulation capable of withstanding locked-rotor for 25 seconds without overheating. Wiring shall also be Class B insulation. An auto-reset thermal cut-out protector shall be embedded in the motor windings to limit heat rise to 175 deg F in a 104 deg F ambient. All motors shall be capable of being replaced by simply disconnecting the wires and then removing mounting bolts. Disassembly of gears shall not be required to remove the motor.
- j. Materials of Construction: The electric actuator shall have a pressure die-cast, hard anodized aluminum base and cover. The compound gear shall be made of die-cast, hard anodized aluminum or steel. An alloy steel worm gear shall be provided for manual override and torque limiting. Bearings for gears shall be of the ball and needle type; bronze bearings shall be used on the shafting parts.
- k. Accessories:
 - 1) Potentiometer for providing continuous feedback of actuator position at the controller (for valves specified position feedback).
- l. Acceptable manufacturers:
 - 1) Honeywell
 - 2) Johnson Controls
 - 3) Belimo

I. Control Valves

- 1. Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5 psig at rated flow (except as may be noted on the drawings). Valves with sizes up to and including NPS 2 shall be "screwed" configuration and NPS 2-1/2 inch and larger valves shall be "flanged" configuration. Electrically controlled valves shall include spring return type actuators sized for tight shut-off against system pressures and furnished with integral switches for indication of valve position (open-closed). Three-way butterfly valves, when utilized, shall include a separate actuator for each butterfly segment.
- 2. Acceptable manufacturers:
 - a. Honeywell
 - b. Belimo

J. Pressure Independent Modulating Control Valves (PICV)

- 1. PICV valves shall have control and flow control performed by the same valve. PICV valves utilizing a separate ball, globe or butterfly valve in association with a dynamic balancing valve or flow measuring station shall not be acceptable.
- 2. Valve bodies 2" (50mm) and smaller shall be brass. Valve bodies 3" thru 6" shall be ductile iron.
- 3. Valves shall have (2) factory installed pressure/temperature ports as part of the actual valve body.
- 4. Piston and Spring Assembly: Stainless steel or corrosion resistant, tamper proof, self cleaning, removable.
 - a. Field adjustable flow rate without removing cartridge from the valve body.
 - 1) In lieu of field adjustability, provide up to 10% of the total project PICV quantity of up or down sized flow rate cartridges as requested by Engineer during TAB.

5. Combination Assemblies: Include bronze or brass-alloy ball valve with stainless steel ball.
6. Identification Tag: Marked with zone identification, valve number, and flow rate.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 250 deg F.
10. Maximum Pressure Drop: 5 ft of head pressure drop at rated flow.
11. Seals: EDPM and Teflon

K. Switches

1. Differential Pressure Switches

- a. All pressure sensing elements shall be corrosion resistant. Pressure sensing elements shall be bourdon tubes, bellows, or diaphragm type. Units shall have tamper-proof adjustable range and differential pressure settings.
- b. Pressure sensor switch contacts shall be snap action micro-switch type. Sensor assembly shall operate automatically and reset automatically when conditions return to normal. Complete sensor assembly shall be protected against vibration at all critical movement pivots, slides and so forth.
- c. Differential pressure switches shall be vented to withstand a 50% increase in working pressure without loss of calibration.
- d. Acceptable Manufacturers: Mercoid, Dryer, McDonnell Miller.

2. Electric Low Limit Thermostat (Freeze Stat)

- a. Duct type, fixed 4 deg F differential, range 32 to 60 deg F. Sensing element shall be a 20 feet long capillary tube responding to the lowest temperature sensed along any 12 inches of bulb length. Switch shall be SPDT 120/240 volts AC, rated for 10 amps at 120 volts full load. Unit shall be manually reset. Provide one low limit thermostat for each 20 sq. ft. or fraction thereof of coil surface area.
- b. Provide DPST switches, 1 NO, 1 NC contact.
- c. Provide manual type low limit thermostat set at 36 deg F on each air handling unit.
- d. Provide thermostat override on air handling units for smoke control in area being served.

3. Water Flow Switches

- a. UL listed, suitable for all service application conditions. Body minimum working pressure rating shall equal or exceed service pressure. Switch electrical rating shall be 230 volts AC 3.7 ampere, 115 volts AC 7.4 ampere, and 125 VAC 115-230 VAC AC Pilot duty. Unit shall have two SPDT switches. Actuating flow rated shall be field adjustable for the specified and indicated service. Switch location shall preclude exposure to turbulent or pulsating flow conditions. Flow switch shall not cause pressure drop exceeding 2 psi at maximum system flow rate.
- b. Acceptable Manufacturer: McDonnell-Miller.

4. Strap-On Aquastat

- a. UL listed, provided with a suitable removable spring clip for attaching aquastat to pipe and a snap-action SPDT switch. Switch set-point shall be as indicated. Electrical rating shall be 5 amperes, 120 VAC.

5. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

L. Flow, Pressure And Electrical Measuring Apparatus

1. Traverse Probe Air Flow Measuring Stations

- a. Traverse probes shall be a dual manifolded, cylindrical, type constructed of 3003 extruded aluminum with an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching air flow and without the physical presence of forward projecting sensors into the airstream. The static pressure manifold shall incorporate dual offset static tips on opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm 20^\circ$ in the approaching airstream.
- b. The air flow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the airstream. Each airflow measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.
- c. Traverse probes shall be accurate to $\pm 25\%$ of the measured airflow range.
- d. Traverse probes shall be accurate to $\pm 25\%$ of the measured airflow range down to 60 Pa static pressure.
- e. Each flow measuring station shall be complete with its own dedicated microprocessor with a 4-line, 80 character, Alpha Numeric display and full function key pad. The panel shall be fully programmable and display calculated liters per minute directly on a LED monitor on the panel face.
- f. Provide 24 volt 1 phase power to each flow measuring station.
- g. Acceptable Manufacturers:
 - 1) Air Monitor
 - 2) Ultratech
 - 3) Air Sentinel.

2. Shielded Static Pressure Sensor

- a. Provide for each zone where required a shielded static pressure sensor suitable for ceiling surface mounting, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 3/8" compression takeoff fittings, all contained in a welded stainless steel casing, with polish finish on the exposed surfaces.
- b. Provide for each zone where required a shielded static pressure sensor suitable for ceiling surface mounting, complete with multiple sensing ports, pressure impulse suppression chamber with minimum volume of 800 cubic centimeters, airflow shielding, and 3/8" compression takeoff fittings, all contained in a welded stainless steel casing, with polish finish on the exposed surfaces.
- c. These probes shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 feet/min. from a radial source.
- d. The shielded static sensing devices shall be used for both reference and space pressure sensing.
- e. Pressure sensors used for outside air pressure reference purposes shall be equipped with a conduit seal for pneumatic tubing and bushings for a weather tight installation.

3. Static Pressure Traverse Probe

- a. Provide multipoint traverse probes in the duct at each point where static pressure sensing is required.
- b. Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Pressure sensing points shall not protrude beyond the surface of the probe.
- c. The duct static traverse probe shall be of 304 stainless steel construction and (except for 3/4" dia. probes with lengths of 24 inches or less) be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure without need for correction factors, with an instrument accuracy of $\pm 1/2\%$.
- d. Acceptable Manufacturers:
 - 1) Auto Tran
 - 2) Veris
 - 3) Setra

M. Relays And Contactors

1. Relays other than those associated with digital output cards shall be general purpose, enclosed type and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.
2. Solid State Relays (SSR): Input/output isolation shall be greater than 10^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz. The contact life shall be 10×10^6 operations or greater. The ambient temperature range of SSRs shall be -18 to 140 deg F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.
3. Contactors: Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semipermanent magnets. Contractor shall be double-break-silver-to-silver type protected by arcing contacts. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

N. Temperature Control Panels

1. Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Panels shall conform to NEMA 1 standards, unless otherwise indicated.
2. Control panels shall meet all requirements of UL508A and shall be so certified.
3. All external wiring shall be connected to terminal strips mounted within the panel.
4. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels and the identification number of the panel.
5. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

O. Variable Frequency Drives

1. Furnish Variable Frequency Drives (VFD) for installation by the electrical contractor (Div. 16). Drives shall be factory equipped with a LonTalk FTT-10A communications interface.

2. The variable frequency drive (VFD) shall generate the required variable frequency through three main input voltage lines connected to an LC filter and diode bridge. This shall produce a DC voltage for an insulated gate bi-polar transistor (IGBT) bridge. The IGBT bridge shall produce a pulse-width modulated (PWM) AC voltage for the motor. A microprocessor shall control the motor according to measured signals and control commands sent from the VFD control panel.
3. The VFD enclosure shall be INSERT ENCLOSURE TYPE (NEMA 1, NEMA 12, OPEN CHASSIS).
4. VFD shall be suitable for INSERT DESIRED VOLTAGE RANGE (208-240 VAC, 380-500 VAC, or 525-690 VAC). The VFD shall maintain functionality from -15% to +10% of nominal voltage at a frequency of 45-66 Hz. Ambient operating temperature range shall be 14 F to 104 F, and the humidity range: 5 to 95% RH (non-condensing).
5. The VFD shall accommodate inputs of 0-10 VDC, 4-20 mA, up to six digital inputs. VFD outputs shall include current of 0-20 mA, 500 ohm maximum with 10 bit resolution, and two programmable changeover relay outputs with switching capacity of 24 VDC, 8A; 250 VAC, 8A; and 125 VDC, 0.4A.
6. The VFD shall accommodate Modbus, LonTalk, and BACnet communications protocols for field bus control.
7. The variable frequency drive shall have separate pre-loaded user-programmable applications which can be modified using a personal computer-based commissioning tool with an optional software package, or an alpha-numeric LCD user interface. Aforementioned application functionality shall include but not be limited to:
 - a. Basic Functionality Application providing the following:
 - 1) Control I/O signals (two (2) analog inputs, one (1) digital input, and one (1) analog output) are fixed
 - 2) One (1) programmable digital input and one (1) programmable digital output
 - 3) All parameters have default values,
 - 4) No more than nine (9) parameter settings are required for startup and operation.
 - b. Expanded Functionality Application providing all capabilities in the previous application as well as the following:
 - 1) One (1) programmable digital input and all outputs are programmable
 - 2) Frequency limit and prohibit capability
 - 3) Programmable start/stop and reversing logic
 - 4) Automatic restart
 - 5) Programmable actions for motor thermal and stall protection
 - 6) DC brake at stop
 - c. Application that provides all previously mentioned capability as well as enabling the use of two different control and frequency sources. Each source must be programmable.
 - d. Application which provides all functionality from the Expanded Functionality Application as well as accommodates multiple, required fixed speed references.
 - e. PID Control Application – Uses internal PID control loop to control motor frequency as well as providing:
 - f. Input and output phase supervision
 - g. Programmable capability for three (3) digital inputs and all outputs
 - h. Sleep function
 - i. Multi-purpose Control Application – The frequency reference can be selected from analog inputs, joystick control, motor potentiometer, or a mathematical function of the analog inputs.
 - j. Application specifically designed to control one leading variable speed drive and up to 3 auxiliary drives.
8. Variable frequency drives shall be UL listed and sized for the power and loads applied.

9. Drives shall include built-in radio frequency interference (RFI) filters and be constructed to operate in equipment rooms and shall not be susceptible to electromagnetic disturbances typically encountered in such environments. Similarly, the drives must not excessively disturb the environment within which it is used.
10. All VFDs over 3 horsepower shall be provided with an AC choke before rectifiers. All included chokes and filters shall be integrated in the factory enclosure.
11. VFDs shall be installed in strict conformance to the manufacturer's installation instructions, and shall be rated to operate over a temperature range of 14 to 104 F.
12. VFD automatic operation shall be suitable for 4-20 ma input signal. Each VFD shall be fan cooled and have an integral keypad and alphanumeric "plain-language" display unit for user interface. The display shall indicate VFD status (RUN motor rotation, READY, STOP, ALARM, and FAULT), and shall indicate the VFD current control source (DDC input signal, keypad, or field bus control). In addition to the alphanumeric display, the display unit shall have three pilot lights to annunciate when the power is on (green), when the drive is running (green, blinks when stopping and ramping down), and when the drive was shut down due to a detected fault (red, fault condition presented on the alphanumeric display).
13. Three types of faults shall be monitored, "FAULT" shall shut the motor down, "FAULT Auto-reset" shall shut the motor down and try to restart it for a programmable number of tries, and "FAULT Trip" shall shut the motor down after a FAULT Auto-reset fails to restart the motor. Coded faults shall be automatically displayed for the following faults:
 - a. Over current
 - b. Over voltage
 - c. Earth ground
 - d. Emergency stop
 - e. System (component failure)
 - f. Under voltage
 - g. Phase missing
 - h. Heat sink under temperature
 - i. Heat sink over temperature
 - j. Motor stalled
 - k. Motor over temperature
 - l. Motor underload
 - m. Cooling fan failure
 - n. Inverter bridge over temperature
 - o. Analog input control under current
 - p. Keypad failure
 - q. Other product unique monitored conditions
14. In addition to annunciating faults, at the time of fault occurrence the VFD shall capture and make available to the user certain system data for subsequent analysis during fault trouble shooting, including duration of operation (days, hours, minutes, seconds), output frequency, motor current, motor voltage, motor power, motor torque, DC voltage, unit temperature, run status, rotation direction, and any warnings. The last 30 fault occurrences shall be retained as well as the fault data listed in the previous sentence of each fault. New faults beyond 30 shall overwrite the oldest faults.
15. The display unit keypad shall allow setting operational parameters including minimum and maximum frequency, and acceleration and deceleration times. The display shall offer user monitoring of faults, frequency, unit temperature, and motor speed, current, torque, power, voltage, and temperature.
16. Acceptable manufacturers:
 - a. ABB

- b. Honeywell
 - c. Square D
- P. Temperature Control Air Compressor (when required): A duplex air compressor system (two compressors mounted on one tank) shall be furnished and installed by the temperature control contractor. Air compressor system shall be sized to fit the pneumatic control system, to insure no more than 33% run time. The tank shall be sized for a maximum of 6 starts per hour. An automatic alternator shall be connected to the motors and pressure switches, in a 'lead-lag' manner, and shall alternate compressor operation after each on-off cycle. Alternator shall be further connected to energize the 'lag' operation after each on-off cycle. Alternator shall be further connected to energize the 'lag' compressor at the setting of the lower pressure switch if the "lead" compressor fails or is disabled for service. Air compressor system shall include a refrigerated air dryer sized for the capacity of the air compressor. Accessories such as filters, pressure regulators, valves, spring isolators, automatic tank drain etc. shall also be furnished for a complete operating system.
- Q. Any automatic control dampers not specified to be integral with other equipment. Frames shall not be less than 0.094 inch galvanized steel. Blades shall not be over 8 inches wide nor less than 0.063 inch galvanized steel roll formed. Bearings shall be oilite, ball-bearing or nylon with steel shafts. Side seals shall be stainless steel of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of -40 to 200 deg F.
- 1. Individual damper sections shall have a maximum of 16 sq. ft. of damper surface and each individual damper section to have its own damper operator.
 - 2. All proportional control dampers shall be opposed blade type and all two-position dampers shall be parallel blade types.
 - 3. Dampers shall be sized to meet ductwork or opening size.
 - 4. Dampers shall be ultra-low leakage dampers and the blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 6 CFM per square foot for dampers in excess of sixteen inches square at 1-inch wg.
- R. Thermally Isolated Dampers: Tampco Series 9000 or equivalent extruded aluminum thermally isolated control dampers with insulated air-foiled shaped blades.
- S. Thermally Isolated Dampers: Ruskin Model CDTI50 or equivalent extruded aluminum thermally isolated control dampers with insulated air-foiled shaped blades.
- 1. Smoke Evacuation System Dampers: UL Listed.
- T. Digital Wall Module: Each wall module shall provide temperature indication to the digital controller.
- 1. Provide software-limited set point adjustment and occupied/unoccupied override capability where indicated.
 - 2. Module mounted adjustments shall use buttons, no slides or wheels.
 - 3. Where indicated, provide plate type security temperature sensors.
- U. Digital Wall Module: Each wall module shall provide temperature indication to the digital controller, provide the capability for a software-limited set point adjustment, occupied/unoccupied override capability and fan speed selection/mode. An integral LCD shall annunciate room temperature, set point, fan speed and operating mode. In addition an integral humidity sensor with display shall be available.
- V. Wireless Temperature Transmitter: Module shall provide temperature indication to the digital system.

1. Supply Power: Lithium batteries, 8 year battery life at 10 second transmit rate
 2. Inputs: Built in thermistor
 3. Accuracy: $\pm 0.2^{\circ}\text{C}$
 4. Transmitted Range: -40° to 85°C
 5. Environmental Operation Range:
 - a. Temp: 0° to 60°C
 - b. Humidity: 5% to 95% RH non-condensing
 6. Material: ABS Plastic
 7. Material Rating: UL94 V-0
 8. Radio Frequency: 418 MHz
 9. Transmitter Interval: ~10 seconds
 10. Antenna: Built inside the enclosure
 11. Associated Products:
 - a. 418 or 900 MHz Receivers: Receives the RF signal from one or more transmitters or repeaters and outputs the values to Analog Output Modules.
 - b. Analog Output Modules: Converts the signal from the Receiver into a resistance, voltage or current for sending to the controller.
 - c. Repeater: Extends the range of the Transmitter up to 1,000 feet.
- W. Power Monitoring Interface: The Power Measurement Interface (PMI) device shall include the appropriate current and potential (voltage) transformers. The PMI shall be certified under UL-3111. The PMI shall perform continuous true RMS measurement based on 32 samples-per-cycle sampling on all voltage and current signals. The PMI shall provide outputs to the BMS based on the measurement and calculation of the following parameters: (a) current for each phase and average of all three phases, (b) kW for each phase and total of all three phases, (c) power factor for each phase and all three phases, (d) percent voltage unbalance and (e) percent current unbalance. These output values shall be hard-wired inputs to the BMS or shall be communicated to the BMS over the open-protocol LAN.
- X. Water Flow Meters: Water flow meters shall be axial turbine style flow meters which translate liquid motion into electronic output signals proportional to the flow sensed. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag. Flow meters shall be 'insertion' type complete with 'hot-tap' isolation valves to enable sensor removal without water supply system shutdown. Accuracy shall be $\pm 2\%$ of actual reading from 0.4 to 20 feet per second flow velocities.
- Y. Duct smoke detectors shall be furnished and connected to the building fire alarm under Division 28. Contacts shall be provided for the BMS contractor to connect for fan shutdown as specified in the Sequence of Operations.
- Z. Carbon Monoxide sensor/transmitter shall be Armstrong Monitoring Corporation AMC-3701 or approved equal. Solid state sensor with 4-20mA linear signal output corresponding to 0-100 PPM CO, Aluminum enclosure, remote calibration feature with non-interactive zero and span, protection against overvoltage and polarity reversal, capable of covering up to 7500 Sq. Ft.. Sensors shall be mounted 3 to 4 feet above finished floor where indicated on drawings.
- AA. Nitrogen Dioxide sensor/transmitter shall be Armstrong Monitoring Corporation AMC-2281 or approved equal. Electrochemical type sensor with 4-20mA linear signal output corresponding to 0-10 PPM NO₂, PVC housing, remote calibration feature with non-interactive zero and span, protection against

overvoltage and polarity reversal, capable of covering up to 7500 Sq. Ft.). Sensors shall be mounted 12 inches below ceiling where indicated on drawings.

BB. Carbon Dioxide sensors shall be 0-10 Vdc analog output type, with corrosion free gold-plated Non-dispersive Infrared sensing, designed for duct mounting. Sensor shall incorporate internal diagnostics for power, sensor, analog and output checking, and Automatic Background Calibration algorithm for reduced maintenance. Sensor range shall be 0-3000 PPM with +/- 5% and +/- 50 PPM accuracy.

CC. Outside Air Inlet Airflow Probes:

1. Provide on outside air dampers bead-in-glass thermistor airflow probes capable of continuously measuring the outside air volume.
 - a. The airflow probes shall be factory calibrated to NIST traceable standards and use thermal dispersion technology.
 - b. The airflow traverse probes shall not significantly impact fan performance or contribute to fan generated noise levels.
 - c. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 2% of actual reading.
2. Include matching factory transmitter with an accuracy of $\pm 0.5\%$ of Natural Span and be furnished with a built-in 3-way zeroing valve, user selectable square root function, and integral 3-1/2 digit scalable LCD for display of measured process. The Transmitter shall be housed in a NEMA 1 NEMA 4 enclosure with universal 1/8" FPT signal connection ports, and provide 0-5 volt, 0-10 volt, or 4-20ma output signals for use by the building control system.
3. Include matching factory transmitter with an accuracy of $\pm 0.5\%$ of Natural Span and be furnished with a built-in 3-way zeroing valve, user selectable square root function, and integral 3-1/2 digit scalable LCD for display of measured process. The Transmitter shall be housed in a NEMA 1 NEMA 4 enclosure with universal 1/8" FPT signal connection ports, and provide 0-5 volt, 0-10 volt, or 4-20ma output signals for use by the building control system.
4. The airflow probes shall be the Ebtron "Gold" Series with class "C" density.

DD. Supply Air fan Inlet Airflow Probes:

1. Provide bead-in-glass thermistor airflow probes on AHU supply fan inlets capable of continuously measuring the supply air volume.
 - a. The airflow probes shall be factory calibrated to NIST traceable standards and use thermal dispersion technology.
 - b. The airflow traverse probes shall not significantly impact fan performance or contribute to fan generated noise levels.
 - c. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 2% of actual reading.
2. Include matching factory transmitter with an accuracy of $\pm 0.5\%$ of Natural Span and be furnished with a built-in 3-way zeroing valve, user selectable square root function, and integral 3-1/2 digit scalable LCD for display of measured process. The Transmitter shall be housed in a NEMA 1 enclosure with universal 1/8" FPT signal connection ports, and provide 0-5 volt, 0-10 volt, or 4-20ma output signals for use by the building control system.

3. Include matching factory transmitter with an accuracy of $\pm 0.5\%$ of Natural Span and be furnished with a built-in 3-way zeroing valve, user selectable square root function, and integral 3-1/2 digit scalable LCD for display of measured process. The Transmitter shall be housed in a NEMA 4 enclosure with universal 1/8" FPT signal connection ports, and provide 0-5 volt, 0-10 volt, or 4-20ma output signals for use by the building control system.
 4. The airflow probes shall be the Ebtron "Gold" Series with class "C" density.
 5. The airflow probes shall be the Ebtron "Gold" Series with class "C" density[or equivalent].
- EE. Airflow Measuring System (Duct Mounted Configuration): Provide where indicated, bead-in-glass thermistor airflow measuring stations capable of continuously monitoring the duct airflow they serve. Each airflow measuring station shall consist of an airflow measuring station and a transmitter.
1. Each airflow traverse probe mounted within the station shall contain multiple total and static pressure sensors located along its exterior surface, and internally connected to their respective averaging manifolds.
 2. The airflow measuring stations shall have a galvanized steel, 6" deep casing with 90° connecting flanges. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular ducts) or at equal concentric area centers (for circular ducts) across the stations face area.
 3. Stations shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of $\pm 2\%$ without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the station shall not exceed .025" w.c. at 2000 FPM, or .085" w.c. at 4000 FPM.
 4. The Transmitter shall have an accuracy of $\pm 0.5\%$ of Natural Span and be furnished with a built-in 3-way zeroing valve, user selectable square root function, and integral 3-1/2 digit scalable LCD for display of measured process. The Transmitter shall be housed in a NEMA 1 aluminum enclosure with universal 1/8" FPT signal connection ports, and provide 0-5 volt, 0-10 volt, or 4-20ma output signals for use by the building control system.
 5. The airflow probes shall be the Ebtron "Gold" Series with class "C" density.

PART 3 - EXECUTION

3.1 GENERAL

- A. The BMS shall be designed, installed, and commissioned in a turnkey operational manner; including all labor not noted in Work by Others paragraph of PART I of this section of these specifications, and not noted in other sections of these specifications.
- B. Where control devices are installed on insulated piping or ductwork, provide standoff brackets or thermowells sized to clear insulation thickness. Provide extended sensing elements, actuator linkages, and other accessories as required.

3.2 SEQUENCE OF OPERATION

- A. Refer to drawings for sequence of operations.

3.3 INSTALLATION

- A. All controls Installer work shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work.
- B. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
- C. Drawings of BMS are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Engineer shall be furnished and installed without additional cost.
- D. Line and low voltage electrical connections to control equipment shown, specified, or shown on the control diagrams shall be furnished and installed by the controls Installer in accordance with these specifications.
- E. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.
- F. All wiring and tubing shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All tubing and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All wiring shall be in accordance with all local and national codes. All line voltage wiring, all wiring exposed, and all wiring in equipment rooms shall be installed in conduit in accordance to the electrical specifications. All electronic wiring shall be #18 AWG minimum THHN and shielded if required, except standard network (Ethernet, LonWorks, etc.) cabling shall be as tested and recommended in lieu of #18 gauge twisted, #22 or #24 gauge is acceptable if used as a part of an engineered structured cabling system. The control manufacturer must submit technical and application documentation demonstrating that this cabling system has been tested and approved for use by the manufacturer of both the control system and the engineered structured cabling system.
 - 1. Low voltage system cables shall be neatly routed and independently supported with cable rings to the nearest cable tray, technology closet, conduit run or equipment connection.
 - 2. All wiring in ceiling plenums shall be plenum rated.
- G. This contractor shall provide all sensing, control, and interlock wiring and tubing for the following unless shown or specified elsewhere by others:
 - 1. Boiler interlocks.
 - 2. Chiller interlocks.
 - 3. Condensing units interlocks.
 - 4. Hydronic piping pressure sensors.
 - 5. CO2 sensors.
 - 6. Connection between occupancy sensors provided by Division 26 and control devices.
 - 7. Air to Air Energy Recovery Unit interlocks.
 - 8. Refrigerant alarm panel interlocks and sensor tubing.
 - 9. Smoke detection devices and HVAC equipment shut-down devices.
- H. The controls contractor shall install all software and enter all computer data into the network area controllers, hardware, and related computers including all control programs, initial approved parameters and settings, and graphics.

- I. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 40 inches above the floor.
- J. For airflow monitoring devices, perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After substantial completion of airflow system, start units to confirm proper operation and readings. Remove and replace malfunctioning units and retest.
 - 2. Test calibration to confirm proper operation and readings.
- K. Install natural gas flow meter at gas service entrance to measure whole facility gas usage, include emergency generator.
- L. Connect to electrical power monitor at main power service entrance disconnect to measure whole facility electrical usage.

3.4 ACCEPTANCE

- A. The BMS contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequences of operations.
 - 1. Coordinate with other Installers the checkout of each controlled system
- B. The controls Installer shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.
- C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- D. System Acceptance: Satisfactory completion is when the controls Installer has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.5 TRAINING (ALTERNATE 1)

- A. All training shall be by the BMS Installer and shall utilize operators' manuals and as-built documentation.
- B. The controls Installer shall provide 40 hours of instruction to the Owner's designated personnel on the operation of the BMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the BMS shall include, but not be limited to; device programming software, graphical development software, graphical user interface, the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.
- C. The training shall be in three sessions as follows:

1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the Owners' personnel can start to familiarize themselves with the system before training begins.
2. Follow-Up Training: Two one day sessions (8 hours each) after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
3. Warranty Follow Up: Two one day sessions (8 hours each) to be scheduled at the request of the Owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

D. On-Line Service: Include 40 hours of on-line service assistance to include but not be limited to:

1. Programming changes or modifications, including changes and adjustments to control algorithms
2. Graphic changes or modifications as requested by the Owner or consulting engineer.
3. Operator assistance to include short (1 hour or less) refresh training on system diagnostics and operation, i.e., geothermal optimization, scheduling, trending or operator setup.
4. Consulting engineer assistance to include assistance on control system optimization.

3.6 POINTS LIST

- A. Refer to drawings for points list. Provide all additional points as required to accomplish all BMS sequences indicated in the drawings and specifications.

END OF SECTION 23 0900

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SECTION 23 1123 - FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Mechanical sleeve seals.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less but not more than 5 psig.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
2. Pressure regulators. Indicate pressure ratings and capacities.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

- B. 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.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.7 COORDINATION

- A. Coordinate the installation of the natural gas service by the local gas utility.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Face: Lapped.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel.
- B. PE Pipe: ASTM D 2513, SDR 11.
 - 1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 - 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 3. Operating-Pressure Rating: 0.5 psig.
 - 4. End Fittings: Zinc-coated steel.
 - 5. Threaded Ends: Comply with ASME B1.20.1.

6. Maximum Length: 72 inches.

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Manual Gas Shutoff Valve Schedules" below for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Tamperproof Feature: Locking feature for valves indicated in "Manual Gas Shutoff Valve Schedule" Articles.
4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Flanged Ends: Comply with ASME B16.5.
4. Tamperproof Feature: Locking feature for valves indicated in "Manual Gas Shutoff Valve Schedule" Articles.
5. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.

4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

1. Body: Bronze, complying with ASTM B 584.
2. Plug: Bronze.
3. Ends: Threaded or flanged.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.

5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.6 SLEEVES

- 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.

2.7 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
 2. Pressure Plates: Plastic.
 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.2 OUTDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install fittings for changes in direction and branch connections.
- C. 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.

- D. 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.
- E. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.3 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install escutcheons at penetrations of interior walls, ceilings, and floors. Comply with requirements in Division 23 Section "Common Work Results for HVAC."
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- L. Verify final equipment locations for roughing-in.
- M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
 - O. Extend relief vent connections for line regulators to outdoors and terminate with weatherproof vent cap.
 - P. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, unless indicated to be exposed to view.
 - Q. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
 - R. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
 - S. Connect branch piping from top or side of horizontal piping.
 - T. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
 - U. Do not use natural-gas piping as grounding electrode.
 - V. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
 - W. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."
 - X. Install automatic gas shutoff valve furnished by food service equipment supplier.
 - Y. Make final connection to gas-fired kitchen equipment furnished by food service equipment supplier.
- 3.4 VALVE INSTALLATION
- A. Install manual gas shutoff valve at each gas-fired piece of equipment.
 - B. Install regulators with maintenance access space adequate for servicing and testing.
- 3.5 PIPING JOINT CONSTRUCTION
- A. Ream ends of pipes and tubes and remove burrs.
 - B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.7 CONNECTIONS

A. Install piping adjacent to appliances to allow service and maintenance of appliances.

B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

1. Install pressure regulator at connection to gas-fired appliance and equipment as required to meet maximum gas pressure requirements of that particular device.

C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for above ground piping and valve identification.

- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Color: Gray.
- C. Paint interior exposed metal piping, valves, and piping specialties in mechanical rooms, except components with factory-applied paint or protective coating.
 - 1. Color: Safety yellow.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be the following:
 - 1. For NPS 2 and smaller, use steel pipe with malleable-iron fittings and threaded joints.
 - 2. For NPS 2-1/2 and larger, use steel pipe with wrought-steel fittings and welded joints.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, distribution piping shall be one of the following:
 - 1. For NPS 2 and smaller, use steel pipe with malleable-iron fittings and threaded joints.
 - 2. For NPS 2-1/2 and larger, use steel pipe with wrought-steel fittings and welded joints.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- B. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 - 1. Bronze plug valve.
- C. Valves in branch piping for single appliance shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

END OF SECTION 23 1123

SECTION 23 3113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes metal ducts for air-distribution systems.
- B. Related Sections include the following:
 - 1. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors, turning vanes, flexible ducts, and flexible connectors.

1.2 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect/Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.3 ACTION SUBMITTALS

- A. Product data for the following items:
 - 1. Sealing Materials.
 - 2. Duct Liner.
- B. Duct Leakage Reports: Submit duct leakage test reports. The reports shall be certified proof that the systems have been leak tested, in accordance with this specification section and the referenced standards and are an accurate representation of the system leakage.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver sealant materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL 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: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- D. 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.
- E. Bird Screen: 1/2 inch mesh, 16 gage galvanized wire.

2.3 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
 - 1. Manufacturers:
 - a. CertainTeed Corp.; Insulation Group.
 - b. Johns Manville International, Inc.
 - c. Knauf Fiber Glass GmbH.
 - d. Owens Corning.
 - 2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

- a. Thickness: 1 inch.
- b. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
- c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
- d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - 1) For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- e. Mechanical Fasteners: Galvanized steel suitable for mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
 - 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.

2.4 SEALANT MATERIALS

- A. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
 - 1. For indoor applications, use adhesive that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- C. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Install structural steel members between building structure members as required for upper attachment of hangers and supports. Use members of size and strength required for span and load. The use of joist or truss bridging for hanging and supporting is prohibited.
- C. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.

- D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- E. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2.6 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 - 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.7 APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. All sizes shown on the drawings for ducts which require duct liner shall be sizes inside the liner.
- B. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- C. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- D. Butt transverse joints without gaps and coat joint with adhesive.
- E. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- F. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- G. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - 1. Fan discharges.
 - 2. Intervals of lined duct preceding unlined duct.
 - 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

- I. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.8 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Spiral Duct Manufacturers:

1. Allied Mechanical Services.
2. Eastern Sheet Metal.
3. SET Duct.
4. LaPine Metal Products.
5. McGill AirFlow Corporation.
6. River City Mechanical.
7. SEMCO Incorporated.
8. Universal Spiral Air.
9. Zinger Sheet Metal.

- B. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

- C. Round, Longitudinal-Seam Ducts: Fabricate 12 inch and smaller ducts and drops to diffusers of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

- D. Round, Spiral Lock-Seam Ducts: Fabricate 13 inch and larger ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

E. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.

- F. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

- G. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

- H. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

2. Round Mitered Elbows: Welded construction with metal thickness equal to or greater than that of ducts.
3. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
5. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30 and 60 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
6. Round Elbows 9 through 14 Inches in Diameter: Fabricate with gored construction, unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
9. Round Gored-Elbow Metal Thickness: Same as metal thickness or greater than that of ducts.
10. Flat-Oval Elbow Metal Thickness: Same as metal thickness or greater than that of ducts.

2.9 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Manufacturers:

1. Allied Mechanical Services.
2. Eastern Sheet Metal.
3. Foremost.
4. LaPine Metal Products.
5. McGill AirFlow Corporation.
6. SEMCO Incorporated.
7. Universal Spiral Air.
8. Zinger Sheet Metal.

B. Ducts: Fabricate double-wall insulated ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
 - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
 - a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
 - b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
 - c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
 - d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.

4. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch- diameter perforations, with overall open area of 23 percent.
 5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.
- C. Fittings: Fabricate double-wall insulated fittings with an outer shell and an inner duct.
1. Solid Inner Ducts: Use the following sheet metal thicknesses:
 - a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
 - b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
 - c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.
 2. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch- diameter perforations, with overall open area of 23 percent.

PART 3 - EXECUTION

3.1 DUCTWORK CONSTRUCTION

- A. Provide ductwork constructed in accordance with SMACNA Duct Construction Standards but no less than the static pressure classification as indicated below. Fabricate ductwork that will have less leakage than the percentage of system design air flow as indicated below. Test all ductwork for leakage, unless otherwise noted, in accordance with SMACNA HVAC Air Duct Leakage Test Manual and the following.
1. VAV Supply Air Ductwork (AHU to Terminal Units)
 - a. Duct Construction Static Pressure Class: +6-inch wg.
 - b. SMACNA Seal Class: A.
 - c. Testing Static Pressure: +6-inch wg.
 2. VAV Supply Air Ductwork (Terminal Units to Diffusers)
 - a. Duct Construction Static Pressure Class: +1-inch wg.
 - b. SMACNA Seal Class: C.
 - c. Testing Static Pressure: No testing required.
 3. Constant Volume Supply Air Ductwork (AHU to Diffusers)
 - a. Duct Construction Static Pressure Class: +3-inch wg.
 - b. SMACNA Seal Class: B.
 - c. Testing Static Pressure: +3-inch wg.
 4. Return Air Ductwork
 - a. Duct Construction Static Pressure Class: -3-inch wg.
 - b. SMACNA Seal Class: B.
 - c. Testing Static Pressure: -3-inch wg.
 5. Exhaust Air Ductwork (To roof fans)
 - a. Duct Construction Static Pressure Class: -3-inch wg.
 - b. SMACNA Seal Class: B.
 - c. Testing Static Pressure: -3-inch wg.
 6. Relief Air Ductwork

- a. Duct Construction Static Pressure Class: +1-inch wg.
 - b. SMACNA Seal Class: C.
 - c. Testing Static Pressure: No testing required.
7. Outside Air Ductwork
- a. Duct Construction Static Pressure Class: -1-inch wg.
 - b. SMACNA Seal Class: C.
 - c. Testing Static Pressure: No testing required.
8. Transfer Air Ductwork
- a. Duct Construction Static Pressure Class: -1/2-inch wg.
 - b. SMACNA Seal Class: C.
 - c. Testing Static Pressure: No testing required.

3.2 DUCT APPLICATIONS

- A. All ducts shall be galvanized steel.

3.3 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- 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. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire and smoke-control dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

- L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Air Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Penetration Firestopping."
- O. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.
- P. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system. Install duct mounted control dampers supplied by Temperature Control Installer.
- Q. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- R. Where indicated, install wire mesh bird screen grilles mounted in a removable frame.

3.4 DUCT CLEANLINESS REQUIREMENTS

- A. Protect duct interiors from the elements and foreign materials in accordance with the following SMACNA's "Duct Cleanliness for New Construction." Guidelines:
 - 1. Advance Level.

3.5 SEAM AND JOINT SEALING

- A. All ductwork shall be suitably cleaned and prepared, and sealant applied in strict accordance with manufacturer's instructions. Manufacturer's recommendations for cure time shall be followed before pressure testing is begun. Any additional paint or coatings must conform to manufacturer's specifications. Seal duct seams and joints as follows:
 - 1. Pressure Classifications Greater Than 3 Inches Water Gage: All transverse joints, longitudinal seams, and duct penetrations (SMACNA Seal Class A).
 - 2. Pressure Classification 2 and 3 Inches Water Gage: All transverse joints and longitudinal seams (SMACNA Seal Class B).
 - 3. Pressure Classification Less than 2 Inches Water Gage: Transverse joints only (SMACNA Seal Class C).
- B. Seal ducts and leak test where indicated before external insulation is applied.

3.6 HANGING AND SUPPORTING

- A. Support ductwork with support systems indicated in SMACNA "HVAC Duct Construction Standards".
- B. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- C. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.7 DUCT SUPPORTS ABOVE ROOF INSTALLATION

- A. Install above roof ductwork supports following support, curb, and roofing manufacturer guidelines. Where necessary, patch roofing in accordance with roofing manufacturer requirements.
- B. New Roof Installations:
 - 1. Curb-Mounted-Type Duct Stands: Assemble components or fabricate duct stand and mount on permanent, stationary roof curb. See Section 23 0500 "Common Work Results for HVAC" for curbs.
- C. Existing Roof Installations:
 - 1. High Type Duct Stand Types: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

3.8 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to 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.
- C. Louver Plenums: Fabricate of heavy gauge sheet metal material in compliance with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - 1. Fabricate with sloped bottom surface.
 - 2. Apply two coats of fire retardant, bitumastic waterproofing material to interior surfaces of bottom and lower half of sides.

3.9 FIELD QUALITY CONTROL

- A. Provide duct leakage testing in accordance with SMACNA HVAC Air/Duct Leakage Test Manual and prepare test reports.
- B. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.
- C. Conduct tests, in the presence of the Architect/Engineer, at static pressures equal to the maximum design pressure of the system or the section being tested. If pressure classifications are not indicated, test entire system at the maximum system design pressure. Do not pressurize systems above the maximum design operating pressure. Give 3 days' advanced notice for testing.
- D. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
- E. Seal and leak test externally insulated ducts prior to insulation installation.
- F. Provide Leakage Testing on ductwork located in inaccessible locations (underslab, in walls and chases, etc.) before final covering is performed.

END OF SECTION 23 3113

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SECTION 23 3300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Fire dampers.
3. Smoke dampers.
4. Combination fire and smoke dampers.
5. Flange connectors.
6. Duct silencers.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.

B. Related Sections:

1. Division 23 Section "Instrumentation and Control for HVAC" for motorized control dampers and damper actuators.
2. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
3. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.2 ACTION SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

1.5 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."

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: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed applications and No. 4 for exposed applications.
- 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 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. Greenheck.
 - e. McGill AirFlow LLC.
 - f. METALAIRE, Inc.
 - g. Nailor Industries Inc.
 - h. Pottorff.
 - i. Ruskin Company.
 - j. Trox USA Inc.
 - k. Vent Products Company, Inc.

2. Standard 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. Bearings:
 - a. Oil-impregnated bronze or molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Damper Hardware:

1. Locking manual quadrant calibrated to show damper position.
2. 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.
3. Include center hole to suit damper operating-rod size.
4. Include elevated platform for insulated duct mounting.

2.3 FIRE 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. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. McGill AirFlow LLC.
6. METALAIRE, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. Pottorff.
10. Ruskin Company.
11. Vent Products Company, Inc.
12. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- E. 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.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. 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.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.4 SMOKE 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. Cesco Products; a division of Mestek, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Pottorff.
 - 6. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: Integral, factory wired for single-point connection.
- D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- F. Leakage: Class II.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

- I. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
- J. Damper Motors: Two-position action.
- K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- L. Accessories:
 - 1. Auxiliary switches for signaling.
 - 2. Momentary test switch, damper mounted.

2.5 COMBINATION FIRE AND SMOKE 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. Cesco Products; a division of Mestek, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Pottorff.
 - 6. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

- G. Leakage: Class II.
- H. Rated pressure and velocity to exceed design airflow conditions.
- I. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
- J. Damper Motors: Two-position action.
- K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- L. Accessories:
 - 1. Auxiliary switches for signaling.
 - 2. Momentary test switch, damper mounted.

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: Add-on or 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 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Industrial Noise Control, Inc.
2. McGill AirFlow LLC.
3. Ruskin.
4. Vibro-Acoustics.
5. Aerosonics
6. Commercial Acoustics
7. Dynasonics
8. Vibron
9. Semco
10. VAW
11. Price-HVAC

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. The dynamic insertion loss in dB for silencers shall not be less than that shown on the Duct Silencer Schedule at the face air velocity of +1,000 fpm (+ indicates airflow in the same direction as attenuation).
5. Duct silencers shall not produce self-noise power levels in dB re 10⁻¹² watts that exceed those shown on the Duct Silencer Schedule.
6. Duct silencers static pressure drop shall not exceed those indicated on the duct silencer schedule for the scheduled airflow velocity and location shown.

C. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.

D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.034 inch thick.

E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.052 inch thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

F. Inner Casing and Baffles: ASTM A 653/A 653M, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch- diameter perforations.

G. Connection Sizes: Match connecting ductwork unless otherwise indicated.

- H. Principal Sound-Absorbing Mechanism:
 - 1. Dissipative type with fill material.
 - a. Fill Material: Inert, mold-resistant, and vermin- and moisture-proof fibrous material.
 - 2. Lining: Tedlar.
- I. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 - 1. Lock form and seal or continuously weld joints.
- J. Accessories:
 - 1. Factory-installed end caps to prevent contamination during shipping.
- K. Source Quality Control: Test according to ASTM E 477.

2.8 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.
- C. 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."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.9 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Ductmate Industries, Inc.
 - 4. Flexmaster U.S.A., Inc.
 - 5. Greenheck Fan Corporation.
 - 6. McGill AirFlow LLC.
 - 7. Nailor Industries Inc.
 - 8. Pottorff.
 - 9. Ruskin.

10. Ventfabrics, Inc.
 11. Ward Industries, Inc.; a division of Hart & Cooley, 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."
- C. Rectangular Ductwork Applications:
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 24 Inches: Three hinges and two compression latches with outside and inside handles.
- D. Round Ductwork Applications:
1. Sandwich Type for Uninsulated Ductwork: Oval shaped inner and outer plates connected by bolt fasteners and compression springs with hand knobs for compression fit in duct sidewall.
 - a. Provide doors with insulated inner plate for installation in pre-insulated double wall ductwork.
 2. Rectangular Type for Insulated Ductwork: Same as specified for rectangular ductwork application with field or factory installed rectangular tap.
- E. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
 2. Door: Single wall for uninsulated duct applications and double wall with insulation fill for insulated duct applications with metal thickness applicable for duct pressure class.
 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 4. Doors close when pressures are within set-point range.
 5. Hinge: Continuous piano.
 6. Latches: Cam.
 7. Seal: Neoprene or foam rubber.
 8. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.
 9. Factory set at pressure settings indicated below:
 - a. Spring clips rated at 3-inch wg negative and 5-inch wg positive for VAV applications.
 - b. Spring clips rated at 2-inch wg negative and 3-inch wg positive for constant volume systems.

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. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.

2.11 FLEXIBLE DUCTS

- A. Insulated, Flexible Duct (Type F-1): UL 181, Class 1, acoustically rated, woven fiberglass fabric with flame resistant coated core supported by helically wound, spring-steel wire; fibrous-glass insulation (R-4.2); bi-directional reinforced metallized vapor-barrier film.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Themaflex Model M-KC or comparable product by the following:
 - a. Flexmaster U.S.A., Inc.
 - 2. Positive Pressure Rating: 16-inch wg positive for sizes 4 to 10 Inches, 10-inch wg positive for sizes 12 to 16 Inches.
 - 3. Negative Pressure Rating: 2.0-inch wg negative for sizes 4 to 16 Inches.
 - 4. Maximum Air Velocity: 6000 fpm.
 - 5. Temperature Range: Minus 20 to plus 250 deg F.
 - 6. Insulation R-value: R-4.2
- B. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or nylon strap in sizes 3 through 18 inches, to suit duct size.

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.
- B. Install duct accessories of galvanized-steel materials in galvanized-steel ducts.
- C. Install turning vanes in all square or rectangular 90 degree elbows.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.
 1. Install steel volume dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install fire and fire/smoke dampers according to UL listing.
- G. Connect ducts to duct silencers rigidly.
 1. Do not locate duct silencers within one duct diameter from fan discharge/intake openings, elbows, or takeoffs.
 2. When elbows precede duct silencer by less than 3 duct widths (as measured in the elbow plane), splitters should be parallel to the plane of the elbow turn.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. At outdoor-air intakes and mixed-air plenums.
 3. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 4. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - a. For fire or smoke dampers located in ducts with no other air path between AHU outlet and damper, install pressure relief access doors upstream of fire or smoke dampers.
 - b. For fire or smoke dampers located in ducts with high velocity and no other air path between AHU outlet and damper, install pressure relief access doors upstream and down stream of fire or smoke dampers.
 - c. For fire or smoke dampers located in ducts with high velocity and other air paths between AHU outlet and damper, install pressure relief access doors down stream of fire or smoke dampers.

5. At each change in direction and at maximum 50-foot spacing.
6. Upstream and downstream from turning vanes.
7. Upstream or downstream from duct silencers.
8. Upstream and downstream of duct mounted airflow monitor devices.
9. At duct mounted smoke detectors.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

I. Access Door Minimum Sizes:

1. Two-Hand or Inspection Access: 12 by 12 inches.
2. Head and Shoulders Access: 20 by 16 inches.
3. Body Access: 24 by 24 inches.
4. For ducts less than 12 by 12 inches

J. Install flexible connectors to connect ducts to equipment.

K. Install flexible ducts as follows:

1. Install flexible ducts at accessible concealed locations only.
2. Connect terminal units to high velocity supply ducts with maximum 18-inch lengths of flexible duct Type F-1, clamped or strapped in place. Flexible ducts are for alignment purposes only. Do not use flexible ducts to change directions.
3. Connect diffusers to ducts directly or with maximum 36-inch lengths of flexible duct Type F-1, clamped or strapped in place. Flexible ducts are for alignment purposes only. Do not use flexible ducts to change directions.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination 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.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 3300

SECTION 23 3423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof ventilators.
 - 2. Ceiling-mounting ventilators.

1.2 PERFORMANCE REQUIREMENTS

- A. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

- D. UL Standard: Power ventilators shall comply with UL 705.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Aerovent; a Twin City Fan Company
 - 3. Greenheck.
 - 4. Loren Cook Company.
 - 5. Penn-Barry.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Motor: ECM with integral speed control.
 - 2. Fan and motor isolated from exhaust airstream.

- F. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.
- G. Accessories:
 - 1. Variable-Speed Controller (Direct Drive Only): Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- H. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing with mounting flange.
 - 2. Overall Height: As scheduled.
 - 3. Pitch Mounting: Manufacture curb for roof slope.

2.2 CEILING-MOUNTING VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Breidert Air Products.
 - 3. Greenheck.
 - 4. JencoFan; Div. of Breidert Air Products.
 - 5. Loren Cook Company.
 - 6. Penn Ventilation.
- B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- C. Housing: Steel, lined with acoustical insulation.
- D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- E. Grille: Louvered grille with flange on intake and thumbscrew attachment to fan housing.
- F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- G. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.

3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support suspended utility set fans from structure using threaded steel rods and vibration isolators.
- C. Secure roof-mounted ventilators to roof curbs with cadmium-plated hardware.
- D. Support suspended ceiling mounted units from structure using threaded steel rods and vibration isolators.
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 23 3423

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SECTION 23 3600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes shutoff single-duct air terminal units.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers:
 - 1. Anemostat; a Mestek Company.
 - 2. Johnson Controls
 - 3. Krueger.
 - 4. Nailor Industries of Texas Inc.
 - 5. Price Industries.

6. Titus.
 7. Trane.
 8. Tuttle & Bailey.
- B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.
- C. Casing: Steel or aluminum.
1. Casing Lining: Minimum 1/2-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive.
 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 3. Air Outlet: S-slip and drive connections.
 4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Velocity Sensors: Multipoint array with velocity sensors in air inlet.
- E. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.
1. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.
- F. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 2. Damper Position: Normally open.
- G. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed. Include the following features:
1. Primary and secondary overtemperature protection.
 2. Nickel chrome 80/20 heating elements.
 3. Airflow switch.
 4. Noninterlocking disconnect switch.
 5. Fuses (for coils more than 48 A).
 6. Mercury contactors.
 7. Magnetic contactor for each step of control (for three-phase coils).
- H. Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation and Control for HVAC."
1. The terminal unit controller flow transducer and damper actuators shall be supplied by the controls contractor for factory installation on the terminal unit. All controls components shall be mounted and wired per the control contractor's documentation. When required the control components shall be installed within a controls enclosure provided by the terminal manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- B. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."
- C. Ground units with electric heating coils according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- E. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing air terminal units, test for compliance with requirements.
 - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 3600

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SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes diffusers, registers, and grilles.
- B. Related Sections:
 - 1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Grilles, Registers and Diffusers:
 - a. Anemostst.
 - b. Krueger.
 - c. Price.
 - d. Tuttle and Bailey.
 - e. Titus.
 - f. Nailor.

2.2 DIFFUSERS

- A. General: Provide manufacturer's standard diffusers where shown; of size, shape, capacity and type as listed on diffuser schedule, with accessories and finishes as indicated.
 - 1. Diffuser Faces:

- a. Square: Square housing; core of square concentric louvers; square or round duct connection.
- b. Rectangular: Rectangular housing; core of rectangular concentric louvers; square or round duct connection.
- c. Panel: Square or rectangular housing extended to form panel to fit in ceiling system module; core of square or rectangular concentric louvers; square or round duct connection.
- d. Slot: Aluminum continuous single or multiple slot with plenum and extended frame to fit in ceiling system module. Provide full coverage 1/2-inch thick coated erosion resistant insulation liner inside plenum.

2. Diffuser Mountings

- a. Surface: Diffuser housing at duct, wall or ceiling surface with gasketed perimeter flange.
- b. Lay-In: Diffuser housing sized to fit between ceiling exposed suspension tee bars and rest on top surface of tee bar.

2.3 GRILLES AND REGISTERS

- A. General: Provide manufacturer's standard grilles and registers where shown; of size, shape, capacity and type as listed on schedule, with accessories and finishes as indicated.

1. Register and Grille Materials:

- a. Steel Construction: Manufacturer's standard stamped sheet steel frame and adjustable blades.
- b. Aluminum Construction: Manufacturer's standard extruded aluminum frame and adjustable blades.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 DIFFUSER, REGISTER, AND GRILLE INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
1. Locate slot diffusers as indicated on general construction drawings. Locate units along one side of acoustical ceiling modules.

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- C. Install diffusers, registers, and grilles with airtight connections to ducts.
- D. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 3713

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SECTION 23 4000 - ANTIMICROBIAL SYSTEMS FOR HVAC

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. Bipolar Ionization.
 - 2. Controls.

1.3 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- B. UV-C: Ultraviolet-C short-wave spectrum.
- C. UV-C Lamp System: Unit including UV lamp, power supply, housing, and supports.
- D. UVGI: Ultraviolet germicidal irradiation.

1.4 QUALITY ASSURANCE

- A. The Air Purification System shall be a product of an established manufacturer in the USA and shall be manufactured and assembled in the USA.
- B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.
- C. Technologies that do not address gas disassociation such as UV lights, powered particulate filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. "Plasma" particulate filters shall not be acceptable.
- D. Projects designed using ASHRAE Standard 62.1 IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1 to validate acceptable indoor air quality at the outside air quantity scheduled. The manufacturer shall provide independent test data on a previous installation in a similar application that proves compliance to ASHRAE 62.1 and the accuracy of the calculations.
- E. The Air Purification Technology shall have been tested by UL or Intertek/ETL to prove conformance to UL 867-2007 including the ozone chamber testing and peak ozone test for electronic devices. All

manufacturers shall submit their independent UL 867 test data with ozone results to the engineer during the submittal process. All manufacturers shall submit a copy with their quotation. Contractors shall not accept any proposal without the proper ozone testing documentation.

- F. Foreign Product Limitations: "Foreign products" as distinguished from "domestic products" are defined as products that are either manufactured substantially (50% or more of value) outside of the United States and its possessions or produced or supplied by entities known to be substantially owned (more than 50%) by persons who are not citizens of nor living within the United States and its possessions. Raw materials shipped from the U.S. to a foreign country for final manufacture or fabrication, shall not qualify.

1. Except where no domestic product is available that complies with the requirements of the contract documents, select and provide domestic, not foreign products, for inclusion in this project.

1.5 ACTION SUBMITTALS

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

1. Product description with complete technical data, performance data, and product specification sheets.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating power, distribution range, control signal over range, default control signal with loss of power, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Installation instructions, including factors affecting performance.

- B. Shop Drawings: For each system.

1. Include plans, elevations, sections, mounting, and attachment details.
2. Include details of system assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Construction Schedule.

- B. Application for Payment and schedule of values.

- C. Qualification Data: For testing laboratory providing data for UV lamps and fixtures.

- D. Product Certificates: For each type of UV lamp, fixture, and system.

- E. Product Test Reports: For each type of UV lamp and fixture, for tests performed by manufacturer and witnessed by a qualified testing agency.

- F. Sample Warranty: For manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lamp systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp and fixture types used on Project.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of products shall be in factory fabricated shipping cartons. Identify on outside of carton the type of product contained within. Avoid crushing or bending.
- B. Store in original cartons and protect from weather and construction work traffic.
- C. Store indoors and in accordance with the manufacturers' recommendation for storage. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.9 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.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period, System: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 MANUFACTURERS

- A. Source Limitations: Obtain from single source from single manufacturer.

2.3 BI-POLAR IONIZATION DESIGN & PERFORMANCE CRITERIA

- A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a plasma ion generator with bipolar ionization output as described here within.
- B. The Bi-polar Ionization system shall be capable of:
 - 1. Effectively killing microorganisms downstream of the bipolar ionization equipment (mold, bacteria, virus, etc.).
 - 2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
 - 3. Reducing space static charges.
 - 4. Reducing space particle counts.
 - 5. When mounted to the air entering side of a cooling coil, keep the cooling coil free from pathogen and mold growth.
 - 6. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:
 - a. MRSA: 99.5% in 60 minutes or less
 - b. E. Coli: 93.5% in 30 minutes or less
 - c. H1N1: 86.6% in 60 minutes or less
 - d. Aspergillus: 74.8% in 60 minutes or less
- C. The bipolar ionization system shall operate in such a manner that equal amounts of positive and negative ions are produced. Single pole ion devices shall not be acceptable.
 - 1. Airflow rates may vary through the full operating range of a VAV system. The quantity of air exchange shall not be increased due to the air purification system requirements.
 - 2. Velocity Profile: The air purification device shall not have a maximum velocity profile.
- D. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions to the air purification system.
- E. Ionization Equipment Requirements:
 - 1. Electrode Specifications (Bi-polar Ionization):
 - a. Each plasma generator with bipolar ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity.
 - b. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.
 - c. Ionization output when tested in the occupied space shall be between 1000 to 1200 ions/cm³.
 - d. Manufacturer shall demonstrate that no voltage potential exists due to exposed electrical components in the duct system or plenum. Exposed needles protruding into the air stream will not be accepted.
 - 2. Air Handler mounted units:
 - a. Ion generators for air handling units 25 tons and larger shall be a linear or bar mounted configuration so as to minimize the space required for installation. Ionization bar shall be no more than 3" deep in the direction of airflow.

- b. The mechanical contractor shall mount the plasma ionization bar and connect it to the remote mount power supply panel using only low voltage wiring. Low voltage wiring shall be defined as 12V. The use of high voltage cabling (600V or higher) shall not be acceptable due to safety concerns.
 - c. The remote mount power supply panel shall be capable of directly accepting voltage of 12V DC or 24V AC. The panel shall have an on/off switch, ionizer indicator LED, and a set of dry contacts which will feedback ionizer functionality. Dry contacts that indicate power available only shall not be acceptable.
 - d. For systems that do not include a feedback electronic signal indicating ion production, provide a duct mounted ion sensor powered from 12V DC or 24V AC. Ion sensor to be user adjustable from 500 to 20,000 ions per cm³ and contain a dry contact BMS interface. To be clear, for systems that only indicate power available to the ionizer, vendor must provide duct mounted ion sensor described herein.
 - e. Needles on air handler mounted units shall be recessed for safety and to avoid fouling of any exposed needles.
- 3. Duct mounted units:
 - a. For systems less than 25 tons and where indicated on the plans and/or schedules to be duct mounted, plasma ion generators similar shall be supplied and installed by the mechanical contractor. The contractor shall follow all manufacturer IOM instructions during installation.
 - b. Ion generators shall be furnished with a factory-equipped gasketed mounting flange to prevent air leakage and to provide a thermal break. Gasketed flange shall be a minimum of 1 1/8" wide around the perimeter of the ionizer.
 - c. Ion generators shall be field installed in a location that is convenient for visual inspection, removal, and servicing. They shall have an on/off switch, ionizer indicator LED, and a set of dry contacts which will indicate ionizer functionality. Dry contacts that indicate power available only shall not be acceptable.
 - d. For systems that do not utilize a feedback functionality wire indicating ion production, provide a duct mounted ion sensor powered from 12V DC or 24V AC. Ion sensor to be user adjustable from 500 to 20,000 ions per cm³ and contain a dry contact BMS interface. To be clear, for systems that only indicate power available to the ionizer, vendor must provide duct mounted ion sensor described herein.
 - e. Needles on duct mounted units shall be recessed for safety and to avoid fouling of any exposed needles.
- 4. Water Source Heat Pumps, VRF, Fan Coil, Unit Ventilators, PTACs:
 - a. Ion generators for WSHP, VRF, FCU, UV, PTAC units shall be brush type needlepoint units designed to be mounted at the fan inlet.
 - b. The unit shall be rated to treat up to 2,400 CFM or 6 tons nominal capacity. For airflows greater than 2,400 CFM, multiple units shall be utilized.
 - c. The PA600 housing is made from ABS plastic, contains an LED ionization output indicating LED, and an in-line 1 Amp fuse.
 - d. The unit shall contain two (2) mounting feet and shall be configured so the needles are oriented perpendicular to the flow of air entering the fan wheel.
- 5. Certifications:
 - a. Bipolar ionization units shall be tested and listed by either UL or ETL according to UL Standard 867 – Electrostatic Air Cleaners. UL listings for standards other than 867 will not be acceptable.

- b. The operation of the electrodes or bipolar ionization units shall conform to UL 867 with respect to ozone generation.

F. Electrical Requirements:

- 1. Ion generators shall contain a built-in power supply and operate on 24V AC and shall connect to the fan and common terminals of the air handling unit served. Ion generators requiring a loose 24V, 120V or 230V transformer or power supply shall not be accepted.
- 2. Wiring, conduit and junction boxes shall be furnished and installed by the electrical contractor within housing plenums and shall be UL and NEC NFPA 70 approved.

G. Control Requirements:

- 1. All plasma ion generators shall include internal short circuit protection, overload protection, and automatic fault reset. Manual fuse replacement shall not be accepted.
- 2. All bar and 7000 series plasma ion generators shall include an external BMS interface to indicate ion generator status and alarm.

H. Accessories:

- 1. Provide to the owner a portable hand held ion counter with a calibrated range of 0 to 20,000 ions/cm³ and an accuracy of +/- 25% within the specified range. Ion counter shall have automatic zeroing capability on 10 minute intervals.

2.4 CONTROLS

- A. Comply with requirements in Section 23 0900 "Direct-Digital Control System for HVAC" for control equipment.
- B. Interface with DDC System for HVAC: Factory-installed hardware and software (where applicable) to enable the DDC system for HVAC to monitor, control, and display status and alarms.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Seal air-handling unit penetrations to maintain integrity of air-handling unit casings.
- B. Housing Installation: Power supply housing can be installed inside or outside air-handling units or plenums.

3.3 ASSEMBLY & INSTALLATION: PLASMA GENERATOR WITH BI-POLAR IONIZATION

- A. All equipment shall be assembled and installed with a high level of workmanship to the satisfaction of the owner, architect and engineer.
- B. Any material damaged by handling, water or moisture shall be replaced by the mechanical contractor at no cost to the owner.
- C. All equipment shall be protected from damage on a daily basis throughout construction.

3.4 ELECTRIC CONNECTIONS

- A. Provide electrical power and service disconnects to products requiring electrical connections.
- B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- C. Comply with requirements for service disconnects in Section 26 2816 "Enclosed Switches and Circuit Breakers."
- D. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- E. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 26 0523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

- A. Identify Bi-polar Ionization system with equipment labels. Comply with requirements for equipment labels specified in Section 23 0553 "Identification for HVAC Piping and Equipment."

END OF SECTION 23 0566

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SECTION 23 7413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Hot-gas reheat.
 - 3. Gas furnace.
 - 4. Economizer outdoor- and return-air damper section.
 - 5. Roof curbs.

1.2 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.3 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
- 1.4 INFORMATIONAL SUBMITTALS
 - A. Field quality-control test reports.
 - B. Warranty: Special warranty specified in this Section.
- 1.5 CLOSEOUT SUBMITTALS
 - A. Operation and maintenance data.
- 1.6 MAINTENANCE MATERIAL SUBMITTALS
 - 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. Filters: One set of filters for each unit.
- 1.7 QUALITY ASSURANCE
 - A. ARI Compliance:
 1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
 - B. ASHRAE Compliance:
 1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
 - C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
 - D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
 - E. UL Compliance: Comply with UL 1995.
 - F. 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 WARRANTY
 - A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. AAON, Inc.
 2. Carrier.
 3. Daikin/McQuay.
 4. Trane.
 5. JCI/York.

2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
- C. Inner Casing Fabrication Requirements:
 1. Inside Casing: Galvanized steel.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 1. Materials: ASTM C 1071, Type I.
 2. Thickness: 1/2 inch.
 3. Liner materials shall have air-stream surface coated with an erosion and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Condensate Drain Pans: Non-corrosive material complying with ASHRAE 62.1.
 1. Drain Connections: Threaded nipple.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

- A. Direct-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- C. Relief-Air Fan: Forward curved, shaft mounted on permanently lubricated motor.
- D. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 COILS

- A. General Requirements for Coil Section:
 - 1. Comply with ARI 410.
 - 2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - 3. Coils shall not act as structural component of unit.
- B. Connections: Provide factory installed piping connection points outside of unit casing and ready for field connections; with casing penetration points sealed against leakage for unit's rated pressure.
- C. Condenser Coils:
 - 1. Condenser coils shall use Micro-Channel coil technology. Coil shall have a series of flat tubes containing a series of multiple, parallel flow micro-channels layered between the refrigerant manifolds. Micro-channel coils shall consist of a two-pass arrangement. Coils shall be factory leak and pressure tested.
- D. Supply-Air Refrigerant Coil:
 - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Coil Split: Interlaced.

2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- B. Refrigeration Specialties:
 - 1. Refrigerant: R-410A.
 - 2. Expansion valve with replaceable thermostatic element.
 - 3. Refrigerant filter/dryer.
 - 4. Manual-reset high-pressure safety switch.
 - 5. Automatic-reset low-pressure safety switch.
 - 6. Minimum off-time relay.
 - 7. Automatic-reset compressor motor thermal overload.
 - 8. Brass service valves installed in compressor suction and liquid lines.

2.6 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated: Minimum 90 percent arrestance, and MERV 13.

2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
 - 1. Fuel: Natural gas.
 - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Venting: Gravity vented.
- E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
- F. Safety Controls:
 - 1. Gas Control Valve: Modulating.
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

- A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 - 1. Damper Motor: Modulating with adjustable minimum position.
 - 2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

- A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."
- B. Interface Requirements for HVAC Instrumentation and Control System:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
 - 3. Provide BACnet compatible interface for central HVAC control workstation for the following:
 - a. Adjusting set points.
 - b. Monitoring supply fan start, stop, and operation.
 - c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
 - d. Monitoring occupied and unoccupied operations.
 - e. Monitoring constant and variable motor loads.
 - f. Monitoring variable-frequency drive operation.
 - g. Monitoring cooling load.
 - h. Monitoring economizer cycles.
 - i. Monitoring air-distribution static pressure and ventilation air volume.

2.11 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Coil guards of painted, galvanized-steel wire.

2.12 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1-1/2 inches.
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.

- B. Curb Height: 14 inches.

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 RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb: Install on roof structure, level and secure. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and route down to roof.
- B. Install piping adjacent to RTUs to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

B. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
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. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Remove packing from vibration isolators.
11. Verify lubrication on fan and motor bearings.
12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Calibrate thermostats.
18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
19. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.

- d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
- 20. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
- 21. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
- 22. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
- 23. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. 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 two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 7413

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SECTION 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical Scope of work
 - 2. Electrical equipment coordination and installation.
 - 3. Rough-in
 - 4. Electrical Demolition
 - 5. Common electrical installation requirements.

1.3 SCOPE OF WORK

- A. The scope of work is to include but not be limited to the following:
 - 1. Obtain all required electrical construction permits and inspections.
 - 2. Provide a 277/480 volt, 3 phase, 4 wire, distribution system for lighting and HVAC equipment.
 - 3. Provide a 120/208 volt, 3 phase, 4 wire, distribution system for convenience receptacles, small appliances and small motors.
 - 4. Refer to mechanical drawings, security, communications and access control drawings. Provide low voltage raceways (1/2" minimum) for all thermostats, controls and low voltage systems. No low voltage wiring of any type shall be visible in exposed ceiling areas.
 - 5. Provide complete electrical installation including all components, i.e. light fixtures, lamps, receptacles, conduit, wire, etc.
 - 6. Provide raceway system for clock/program , and security systems, refer to technology drawings.
 - 7. Provide raceway system for telephone/data networking systems, refer to technology drawings.
 - 8. Provide for Owner training by factory representatives in operation and maintenance of systems where specified.
 - 9. Submit documentation such as shop drawings, record documents, maintenance manuals, infrared scan results, systems test results, fire alarm system certification, etc. as specified.

1.4 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 electrical systems, equipment and materials installation with other building components.
- C. Coordinate installation of electrical panelboard tubs, backboxes and concealed conduit and tubing with masonry/concrete work.
- D. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
- E. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- F. 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."
- G. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.5 INTERPRETATIONS

- A. It is the intent of these Drawings and Specifications to result in a complete electrical installation in complete accordance with applicable code and ordinances.
- B. Drawings are diagrammatic in character and do not necessarily indicate every required junction box, pull box, ell, etc. Items not specifically mentioned in the specification or noted on the Drawings, but which are necessary to make a complete working installation, shall be included.
- C. Drawings and Specifications are complementary. Whatever is called for in either is binding as though called for in both. The more stringent requirement shall govern.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 ELECTRICAL DEMOLITION

- A. Disconnect, demolish, and remove electrical system equipment and components indicated to be removed.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

- C. Inaccessible Work: Cut and remove buried raceway and wiring, indicated to be demolished, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. All existing fixtures, equipment, etc., that are removed and not indicated to be relocated, or reused, shall first be offered to the Owner, after Owner has approved, the remaining removed items shall become property of the Contractor and shall be removed from the building site.
- E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- F. Protect existing electrical equipment and installations not indicated to be removed. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- G. Contractor shall examine the Drawings and Specifications, and existing conditions. All costs relating to maintaining existing services or relocating existing circuits and/or equipment shall be included in the bid. Contractor is required to complete all work necessary to meet these requirements without additional expense to the Owner or his Representative.
- H. Equipment Replacement: Contractor shall verify all circuit breakers and fuse sizes against the existing wire size prior to replacing switchboards, panelboards and disconnect switches. Notify the Architect of any discrepancies prior replacing equipment.

3.2 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 02 through 49 for rough-in requirements.

3.3 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1, Standard Practices for Good Workmanship in Electrical Construction.
- B. Arrange for chases, slots and openings in other building components during progress of construction, to allow for electrical installations.
- C. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- D. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- F. 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.

- G. 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.
- H. Right of Way: Give to piping systems installed at a required slope.

3.4 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 Section "Penetration Firestopping."

END OF SECTION 26 0500

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 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.

1.2 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Conductor Material: Copper complying with NEMA WC 70/ICEA S-95-658.
- B. Conductor Insulation Types: Type THHN-2-THWN-2, Type XHHW-2 and Type SO

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Minimum conductor size for power wiring #12 AWG.
- B. Service Entrance: Type THHN-2-THWN-2, single conductors in raceway.

- C. Exposed Feeders: Type THHN-2-THWN-2, single conductors in raceway.
- D. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
- E. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- F. Emergency Power Feeder: Provide a listed electrical circuit protective system with a minimum 1-hour fire rating.
- G. Emergency Power Branch Circuits: Provide a listed electrical circuit protective system with a minimum 1-hour fire rating, where indicated on plans.
- H. Exposed Branch Circuits, including in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- I. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-2-THWN-2, single conductors in raceway.
- J. Fixture Whips: Type MC cable may be used for light fixture whips only, with a maximum length of 6 feet.
- K. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-2-THWN-2, single conductors in raceway.
- L. Underground Feeders and Branch Circuits: Type THHN-2-THWN-2, single conductors in raceway.
- M. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- N. Fire Alarm Circuits: Type THHN-2-THWN-2, in raceway or Power-limited, fire-protective, signaling circuit cable where raceway is not specified.
- O. Class 1 Control Circuits: Type THHN-2-THWN-2, in raceway.
- P. Class 2 Control Circuits: Type THHN-2-THWN-2, in raceway or Power-limited cable, concealed in building finishes where raceway is not specified.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Where 120 volt, 20 amp, branch circuit wiring from panelboard to first outlet exceeds 100 feet in length, increase home-run wire size to #10 AWG.
- B. Where 277 volt, 20 amp, branch circuit wiring from panelboard to first light fixture exceeds 150 feet in length, increase home-run wire size to #10 AWG.
- C. Common neutral conductors **shall not** be used for convenience outlet or lighting branch circuits.
- D. Neutral conductors shall be clearly labeled at the panelboard with the circuit number of associated phase conductors.

- E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- F. 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.
- G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- I. Support cables according to Division 26 Section "Common Work Results for Electrical."
- J. Seal around cables penetrating fire-rated elements according to Division 07 Section "Penetration Firestopping."

3.3 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 0553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. 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 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.
- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with IEEE837 – Standard for qualifying permanent connections used in Substation Grounding

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Copperweld Corp.
 - b. Erico Inc.; Electrical Products Corporation.
 - c. FCI Burndy Products.
 - d. Ideal Industries, Inc.
 - e. ILSCO.
 - f. Kearney/Cooper Power Systems.
 - g. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - h. Raco, Inc.; Division of Hubbell.
 - i. Thomas & Betts, A Member of the ABB Group.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: tinnedstranded unless otherwise indicated.
- F. 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 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 wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- G. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

- 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.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Compression Connectors: Irreversible hydraulic compression kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- E. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long barrel, two-bolt connection to ground bus bar

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Sectional type; copper-clad steel.

1. Size: $\frac{3}{4}$ inch in diameter by 120 inches long.
- B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded or Irreversible Compression Connections: Use for connections to structural steel and for underground connections.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Install equipment grounding conductors or grounding electrode conductors that are routed through exposed ceiling spaces in conduit.
- F. Label equipment grounding conductors and grounding electrode conductors as indicated in "Identification for Electrical Systems".
- G. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.
- H. Grounding Bus: Install in electrical service equipment rooms.
 1. Size: 1/4 inch by 2 inches bare, annealed copper.
 2. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
 3. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.
- I. Underground Grounding Conductors: Use tinned-copper conductor, No. 2/0 AWG minimum unless noted otherwise. Bury at least 24 inches below grade.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. 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.
 8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

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. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
1. Drive ground rods until tops are 6 inches below finished floor or final grade, unless otherwise indicated.
 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except as otherwise indicated. Make connections without exposing steel or damaging copper coating.
 3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. 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.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
4. Bond all steel structure and concrete reinforcement steel / rebar.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Concrete-Encased Electrodes: Connect grounding conductor to the foundation reinforcing bars or rods and bond the bars together with steel tie wires.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding Variable-Frequency Motors: Provide copper braided grounding strap between motor and metallic conduit (EMT or IMC) in addition of the equipment grounding conductor on motors controlled with a variable-frequency controller.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing.

Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

- E. Tighten screws and bolts for grounding and bonding 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.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Duct Banks: Install a grounding conductor with at least 50 percent ampacity of the largest phase conductor in the duct bank.
- B. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Duct Banks: Install a grounding conductor with at least 50 percent ampacity of the largest phase conductor in the duct bank.
- B. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-

sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

- C. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.7 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.
- B. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.
 - 5. Manhole Ground: 10 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

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END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of 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/ A Member of the ABB Group.

- f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 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. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. 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.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. 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. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated 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. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
 - 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 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 Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to trapeze member with clamps approved for application.
 - 2. 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 and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Provide independent support rings/shepherd hooks for any low voltage communications systems cabling. Cabling shall not rest on ceiling and shall be organized neatly on hooks. Cable shall not be visible in exposed ceiling spaces.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 for installation requirements, except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.
- C. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.

- D. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or spring-tension clamps.
 - 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.
- F. 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.
- D. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.
- B. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- C. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 3000 "Cast-in-Place Concrete."
- D. 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.
- 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.
 - 1.

END OF SECTION 26 0529

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SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.2 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit

1.3 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, hand holes and attachment details.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

1.5 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew or compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- H. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ENT: Comply with NEMA TC 13 and UL 1653.
- C. RNC: Type EPC-40-PVC and EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.
- E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- F. Fittings for LFNC: Comply with UL 514B.
- G. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- H. Solvent cements and adhesive primers 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."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R as required.
- B. 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.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- D. Wireway Covers: Hinged type, Screw-cover type, Flanged-and-gasketed type.
- E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Metal Floor Boxes:
 - 1. Material: Sheet-metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

- I. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.
- J. Telephone/Data Backboxes: Provide 2-gang, 3 ½ inch deep backboxes with single gang raised cover unless noted otherwise on plans.
- K. Low Voltage Boxes: 5-Square telecommunications outlet boxes (5 in. square x 2.875 deep w/ cable management) shall be used for all low voltage applications. 5-square box shall support 5e, 6, augmented 6, 7, and optical fiber cables. Low voltage boxes shall support integral cable management by allowing slack cable to be wound internally while maintaining minimum bend radius requirements. 5-square boxes shall also be used for all fire alarm applications.

2.5 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard gray paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

2.6 CABLE PATHWAY AND FIRESTOP DEVICE

- A. Manufacturer:
 - 1. Specified Technologies, Inc., EZ-Path fire rated pathway.
 - 2. Wiremold, FlameStopper FS Series thru-wall fitting for fire walls.
- B. Description: Through-the-wall 3" x 3" steel wiring channel or 4" EMT equipped with heat expanding intumescent fire stopping material.
- C. Wiring channel shall be provided with steel wall plates allowing for single or multiple channels to be ganged together.
- D. Wiring channel shall have an F rating equal to the rating of the barrier in which it is installed.
- E. Wiring channel shall be capable of allowing a 0 to 100 percent visual fill of cable.
- F. Wiring channel shall be tested in accordance with ASTM E 814 (ANSI/UL1479). Channel shall bear the UL classification marking.
- G. Provide the quantity of devices needed to allow a cable pass cross section capacity of 50 percent of the adjacent cable tray cross section.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 1. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC".
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Wall Style: Flared wall assembly.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors:
 1. Exposed: Rigid steel or IMC.
 2. Concealed, Aboveground: Rigid steel or IMC.
 3. Underground: RNC Schedule 40.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures: NEMA 250, Type 3R or 4.
- B. Indoors:
 1. Exposed in Unfinished Utility Spaces (mechanical rooms, electrical rooms and tunnels): EMT.
 2. Exposed in Finished Spaces: All conduit shall be concealed unless specifically indicated on plans.
 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC.
 4. Concrete Floors: RNC.
 5. Concealed in Ceilings and Interior Walls and Partitions: EMT
 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 7. Damp or Wet Locations: Rigid steel conduit or IMC.
 8. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
- C. Minimum Raceway Size: 1/2-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this Article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Provide separate raceways for lighting, receptacle, and motor loads. Do not mix branch circuit wiring for these different loads in the same raceway.
- C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- D. Complete raceway installation before starting conductor installation.
- E. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Support raceways as specified in Division 26 Section "Common Work Results for Electrical."
- G. Install temporary closures to prevent foreign matter from entering raceways.
- H. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above finished slab.
- I. 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.
- J. Make bends and offsets so ID is not reduced. Keep legs of bends in same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- K. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
 - 2. Conduit and EMT may be surface mounted in Mechanical and Electrical Rooms except for wiring devices, light switches, low voltage devices or any other device shall be concealed in new wall.
 - 3. Surface mounted conduit or EMT may be used where specifically approved by Architect/Engineer. In such situations, the conduit, fastening devices, and junction boxes shall be painted to match the adjacent surface.
- L. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to rigid steel conduit, or IMC before rising above floor.
- M. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.

2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- N. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- O. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors.
- P. Tighten set screws of threadless fittings with suitable tools.
- Q. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
 3. Telephone, data and fiber optic cable conduits shall be provided with bushings on conduit ends.
- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- S. Color-Coding: Paint fire alarm system junction boxes and covers red.
- T. Raceways for Optical Fiber and Communications Cable: Install as follows:
1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 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.
- U. Telephone, data, AV, security, access control, fiber optic cable system, building control cabling, lighting control, 0-10V dimming control and any other low voltage systems cabling shall be installed in conduit in areas of exposed ceiling. In areas with accessible ceilings, the low voltage systems cables shall be neatly routed and independently supported with cable rings to the nearest cable tray, technology closet, conduit run or equipment connection. Systems to be in conduit in accessible ceiling spaces where required elsewhere in the specification or drawings.
- V. Telephone, data and fiber optic cable system conduit shall be provided with wide sweep bends.
- W. Telephone, data and fiber optic cable outlets shall be provided with a 1 inch conduit stubbed into accessible ceiling space unless noted otherwise on the drawings. Provide bushings on the ends of the conduit.
- X. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-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 spaces.
2. Where otherwise required by NFPA 70.

Y. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

AA. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

BB. Flexible Connections to Lighting Fixtures:

1. Above ceilings that are continuous to wall: Provide flexible conduit to all recessed lighting fixtures, maximum length as indicated. For fixtures mounted on grid ceilings, provide adequate length of flexible conduit to allow relocation of fixture on grid space in any lateral direction.
2. Above clouds or above suspended ceiling elements that are visible and exposed, Flexible Connections to Lighting Fixtures shall be limited to reduce sight of flexible conduit. Flexible connections to light fixtures shall not be visible from standing on the floor or nearby landings or overlooks. Minimize angle of visibility, run EMT as necessary and coordinate with trades to group systems to minimize drops. All drops to element/cloud to be EMT or IMC and shall not be flex.

CC. Equipment Grounding Conductor: Install a green equipment grounding conductor in all flexible conduit and non-metallic (PVC) conduit.

- DD. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- EE. Recessed back-to-back boxes are not permitted in the same wall. Arrange boxes with at least 12 inches of horizontal spacing.
- FF. Recessed Boxes in Masonry Walls: Saw-cut opening for box in masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- GG. Locate boxes so that cover or plate will not span different building finishes.
- HH. Set floor boxes level and flush with finished floor surface.
- II. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- JJ. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- KK. Provide stainless steel cover plates on all abandoned boxes that remain from selective demolition.
- LL. Cable pathway and firestop device: Install in locations where indicated on the plans. Arrange singly or in gangs and mounted above accessible ceilings. Install the devices in strict accordance with the manufacturer's recommendations.

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 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 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 duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout length elbow.
5. 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 of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

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 sieve to No. 4 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 above finished grade.
- D. Install handholes with bottom below frost line 42" below grade.
- E. 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 AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413 "Penetration Firestopping."

3.7 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.

3.8 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 0533

SECTION 26 0544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Exterior Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.

2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel.
 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Presealed Systems.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sealant shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 0544

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for 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.

1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 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.

1.4 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 RACEWAY AND 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 size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange 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.
- D. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 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.
- C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- 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.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend, machine printed by thermal transfer or equivalent process.

2.4 NAMEPLATES AND SIGNS

- A. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

- B. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.
- C. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.
- D. 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.

2.5 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 utility 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.
- 4. Not less than 6 inches wide by 4 mils thick.
- 5. Compounded for permanent direct-burial service.
- 6. Embedded continuous metallic strip or core.
- 7. Printed legend indicating type of underground line.

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.

2.6 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. 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.

C. Baked-Enamel Warning Signs:

- 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
- 2. 1/4-inch grommets in corners for mounting.
- 3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. 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."

2.7 EQUIPMENT IDENTIFICATION LABELS

- A. 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. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. 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.
- C. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.8 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. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

- E. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- F. Circuits with More Than 600 V: Identify raceway and cable with "DANGER--HIGH VOLTAGE" in black letters 2 inches high, stenciled with paint at 10-foot intervals over a continuous, painted orange background. Identify the following:
 - 1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to conduits concealed within wall.
 - 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in the building, or concealed above suspended ceilings.
 - 4. Entire surface of exposed conduits.
- G. Install painted identification according to manufacturer's written instructions and as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime surfaces using type of primer specified for surface.
 - 3. Apply one intermediate and one finish coat of enamel.
- H. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- I. Circuit Identification on Device Plates.
 - 1. Identify circuits feeding receptacles with the designation of the panelboard and the circuit number in permanent marker on the back of each device cover plate.
 - 2. In mechanical, technology closets, electrical rooms and industrial type spaces, provide typed self-adhesive plastic labeling on outside of cover-plate to indicate the circuit number.
- J. Circuit Identification Labels on Boxes: Install labels externally.
 - 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 - 2. Concealed Boxes: Plasticized card-stock tags.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- K. 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 maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- L. Underground-Line Warning Tape: During backfilling of trenches, install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 20-foot maximum intervals.

- B. 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. Emergency Power.
 2. Power.
- C. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder and branch-circuit phase conductors:
1. 208/120-V Conductors:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
 2. 480/277-V Conductors:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Slate/Gray.
 - e. Ground: Green.
 3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches 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. Use 1-inch- wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- D. Provide labelling of each independent, conductors at 50' maximum centers, label at equipment and label at bus bars. Separate ground conductors routed concealed within conduit shall have conduit labels to identify the grounding conductor equipment or grounding/bonding location.
- a. Indicate what equipment is fed or where the equipment is fed from on the label.
 - b. At service grounding bus bar, label "service grounding electrode conductor" at service entrance ground and label the equipment served by each equipment ground conductor.
- E. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- F. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- G. 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.
- H. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer, load shedding and multiple services.
- I. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- high lettering on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Electrical switchgear and switchboards.
 4. Emergency system boxes and enclosures.
 5. Disconnect switches.
 6. Enclosed circuit breakers.
 7. Boiler shut-offs.
 8. Power transfer equipment.
 9. Control devices.
 10. Transformers.
 11. Power-generating units.
 12. Clock/program master equipment.
 13. Call system master station.
 14. Fire alarm control panel.
 15. Security-monitoring master station or control panel.

END OF SECTION 26 0553

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SECTION 26 0800 - COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes commissioning process requirements for electrical systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.
 - 2. Division 22 Section "Commissioning of Plumbing" for plumbing commissioning requirements.
 - 3. Division 23 Section "Commissioning of HVAC" for HVAC commissioning requirements.

1.2 ABBREVIATIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for list of abbreviations used in the Specifications and in the Commissioning Plan.

1.3 DEFINITIONS

- A. Refer to Division 01 Section "General Commissioning Requirements" for list of definitions used in the Specifications and in the Commissioning Plan.

1.4 COORDINATION

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to coordination during the commissioning process.

1.5 COMMISSIONING PROCESS

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to the commissioning process.

1.6 COMMISSIONING TEAM RESPONSIBILITIES

- A. Provide information requested by the CxA for final commissioning documentation.
 - 1. Test reports
- B. Assist the CxA in all verification and functional performance tests.
- C. Refer to Division 01 Section "General Commissioning Requirements" for additional requirements pertaining to the contractor responsibilities.

1.7 SYSTEMS TO BE COMMISSIONED

- A. Any electrical equipment or systems that are monitored and or controlled by Building Management System will be commissioned with no sampling methods.
 - 1. Lighting Control system.
 - 2. Electrical Meters.
- B. Refer to Division 01 Section "General Commissioning Requirements" for electrical systems to be commissioned.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Refer to Division 01 Section "General Commissioning Requirements" for test equipment requirements.

PART 3 - EXECUTION

3.1 MEETINGS

- A. Refer to Division 01 Section "General Commissioning Requirements" for meeting requirements.

3.2 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

- A. No commissioning checklists will be required to be completed by Electrical contractor.
- B. Refer to Division 01 Section "General Commissioning Requirements" for additional participation requirements for start-up, prefucntional checklists and initial checkout.

3.3 FUNCTIONAL PERFORMANCE TESTING

- A. Sampling: No sampling of any equipment will be permitted. All equipped or types referenced in Division 01 Section "General Commissioning Requirements" will be 100% sample rate regardless of qty or size of equipment or system.
- B. Refer to Division 01 Section "General Commissioning Requirements" for additional participation requirements for functional performance testing.

3.4 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Refer to Division 01 Section "General Commissioning Requirements" for approval procedures.

3.5 DEFERRED TESTING

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to deferred testing.

3.6 WRITTEN WORK PRODUCTS

- A. Refer to Division 01 Section "General Commissioning Requirements" for requirements pertaining to written work products related to the commissioning process.

END OF SECTION 26 0800

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SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Indoor occupancy switchbox-mounted occupancy and outdoor motion sensors.
 - 4. Emergency lighting devices.
- B. Related Requirements:
 - 1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data

1.5 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

DIGITAL OCCUPANCY SENSORS AND DIMMERS

- A. Manufacturers:
 - 1. Crestron.
- B. Digital System Occupancy Sensors
 - 1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.

2. All Sensors must be programmed for Vacancy Sensor operation for all rooms except for corridors and restrooms. Corridors and restrooms shall have the occupancy sensor turn the lights on when human activity is detected. The Digital Switch must be pressed for lighting to turn ON, and OFF. The sensor is for Automatic OFF ONLY.
3. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
4. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.
5. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
6. All sensing technologies shall be acoustically passive meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
7. Sensors shall be available with zero, one, or two integrated Class 1 switching relays, and up to one 0-10 VDC dimming output. Sensors shall be capable of switching 120 / 277 / 347 VAC. Load ratings shall be 800 W @ 120 VAC, 1200 W @ 277 VAC, 1500 W @ 347 VAC, and ¼ HP motor. Relays shall be dry contacts.
8. Sensors shall be available with one or two occupancy "poles", each of which provides a programmable time delay.
9. Sensors shall be available in multiple lens options which are customized for specific applications.
10. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
11. All sensors shall have two RJ-45 ports.
12. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
13. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
14. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
15. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.
16. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
17. Wall switch sensors must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable. Sensor shall not allow current to pass to the load when sensor is in the unoccupied (Off) condition.
18. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.
19. Wall switch sensors shall be available in four standard colors (Ivory, White, Light Almond, Gray)
20. Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified. See Drawings for Details and Part Numbers.
21. Network system shall also have ceiling, fixture, recessed, & corner mounted sensors available.
22. Sensors shall have optional features for photocell/daylight override, dimming control, and low temperature/high humidity operation.

23. Sensors with dimming can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of Class 2 current (typically 40 or more ballasts).
 24. Sensors shall be the following Sensor Switch model numbers, with device options as specified: See Drawings for Details and Part Numbers.
- C. Digital System Power (Relay) Packs
1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
 2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
 3. All devices shall have two RJ-45 ports.
 4. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
 5. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
 6. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass
 7. through chase nipple into adjacent junction box without any exposure of wire leads.
 8. Power (Secondary) Packs shall be available that provide up to 16 Amp switching of all load types, and be rated for 400,000 cycles.
 9. Specific Secondary Packs shall be available that provide up to 5 Amps of switching as well as 0-10 VDC dimming of fluorescent ballasts.
 10. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
 11. Specific Secondary Packs shall be available that provide up to 5 Amps of switching of dual phase (208/240/480 VAC) lighting loads.
 12. Specific Secondary Packs shall be available that require a manual switch signal (via a networked Wall Station) in order to close its relay.
 13. When Required Specific Emergency Secondary Power Packs shall be available to provide switching up to 5 Amps at 120 or 277v and must hold a UL924 Listing.
 14. Provide auxiliary relay for connection to building management system.
 15. Power (Relay) Packs and Supplies shall be the following Sensor Switch model numbers: See Drawings for Details and Part Numbers.
- D. Digital System Wall Switches & Dimmers
1. Devices shall recess into single-gang switch box and fit a standard GFI opening.
 2. Devices shall be available with zero or one integrated Class 1 switching relay.
 3. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
 4. All sensors shall have two RJ-45 ports.
 5. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
 6. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).

7. Devices with dimming control outputs can control 0 to 10 VDC dimmable ballasts by sinking up to 20 mA of current (typically 40 or more ballasts).
8. Devices with capacitive touch buttons shall provide audible user feedback with different sounds for on/off, raise/lower, start-up, and communication offline.
9. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
10. Devices with mechanical push-buttons shall be made available with custom button labeling
11. Devices with a single on button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.
12. Wall switches & dimmers shall be the following Sensor Switch model numbers, with device options as specified: See Drawings for Details and Part Numbers.

2.2 OUTDOOR MOTION SENSORS (PIR)

- 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 or a comparable product by one of the following:
 1. Crestron.
- D. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.
 1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 3. Bypass Switch: Override the on function in case of sensor failure.
 4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc(11 to 215 lx); keep lighting off during daylight hours.
- E. Detector Sensitivity: Detect occurrences of 6-inch-(150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.(232 sq. cm).
- F. Detection Coverage: Up to 35 feet(11 m), with a field of view of 180 degrees.
- G. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.
- H. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

EMERGENCY LIGHTING DEVICES

- I. Manufacturers:
 - 1. Iota Engineering
 - 2. LVS, Inc.
 - 3. Philips Bodine
- J. Description: Generator (or central inverter) supplied egress lighting shall be provided by using a fixture equipped with an emergency lighting device (sometimes referred to as a generator transfer device).
 - 1. The device shall be capable of bypassing the wall switch or other lighting controls when the normal power fails to the fixture and transfer to emergency power.
 - 2. Device shall operate at 120 or 277 VAC, 60 Hz;
 - 3. Device shall comply with the NEC.
 - 4. The device shall be UL 924 Listed for installation inside, on top of or remote from the fixture.
 - 5. In a DALI system, the system shall be UL 924 and programmed to turn on affected zones when a power loss is detected and to fail closed. ELD devices are not required with a DALI, UL 924 listed system when configured to meet emergency lighting requirements upon branch circuit power failure.
 - 6. The device shall be warranted for a full five years from date of purchase.

2.3 EMERGENCY SHUNT RELAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lighting Control and Design, Inc.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
 - 1. Coil Rating: 277 V.

2.4 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No.14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

- B. Install ceiling mounted sensors in the center of the lay-in ceiling tile when available.
- C. Install power packs above the accessible ceiling at the light switch location in room. If room does not have accessible ceiling and the adjacent corridor does, then install on corridor side. Install power pack in junction box to conceal the termination if installed on an exposed ceiling.
- D. Install according to manufacturer's recommendations.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm). All low voltage and communication cabling shall be run in conduit, refer to Section 26 0533 – Raceways and Boxes for Electrical Systems.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- F. 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.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify actuation of each sensor and adjust time delays.

- B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 ADJUSTING

- A. Adjust time delay on each sensor to 15 minutes unless noted otherwise on plans.
- B. Coordinate light sensor level with owner to determine preferred operating range.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 26 0923

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SECTION 26 0943 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

SCHEDULE 0 - SUMMARY

PRODUCT DATA SHEET 0 - Section Includes:

1.1 Networked Central Lighting Control systems. Systems are composed of:

- A. Network integrated power switching systems.
- B. Network integrated dimming systems.
- C. Standalone power switching and dimming systems.
- D. DALI-compliant network integrated lighting controller.
- E. Automation control processors.
- F. Sensors
- G. User Interfaces:
 - 1. Keypad
 - 2. Touch screen
 - 3. Virtual touch screen

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each relay panel and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail wiring partition configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of relays.
 - 5. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- B. Field quality-control reports.
- C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- D. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panels for installation according to NECA 407.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.
- E. Comply with NFPA 70.
- F. Lighting control relay panels shall be UL 916 Listed.
- G. Lighting control relay panels controlling emergency circuits shall be ETL listed to UL 924. Emergency source circuits controlled in normal operation by a relay panel shall fully comply with NEC 700-9(b). Electrical contractor to verify compliance.
- H. The lighting control system shall also be listed or approved by all national, state and local energy codes to include but not limited to California Title 24 and ASHRAE 90.1-2007.

1.7 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of lighting control functions.
 - 2. Coordinate lighting controls with HVAC controls. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
 - 3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

- B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.8 WARRANTY

PRODUCT DATA SHEET 1 - Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of modular dimming controls system the fail in materials or workmanship within the specified warranty period following substantial completion.

1.1Warranty Period: Touch screen display and overlay components: 90 days.

1.2Warranty Period: Disc drives and other moving parts, pan/tilt heads, and power supplies: 1 year.

1.3Warranty Period: Other components, up to 5 years as per warranty contract.

PRODUCT DATA SHEET 2 - Manufacturer's Extended Support Service: Extended telephone support: Unlimited period.

1.1 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. Relays: Equal to 10 percent of amount installed for each size indicated, but no fewer than 10 relays.
2. Manual Switches: Provide 10% additional Control Stations.

1.2 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.
1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

- 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. Crestron Electronics Inc. – Showrunner System

2.2 SYSTEM REQUIREMENTS

The lighting control system is a networked system that communicates via RS485. The system must be able to communicate with fully digital centralized relay panels, micro relay panels, smart breaker panels, digital switches, photocells, various interfaces and shall include all operational software. The intent of the specification is to integrate all lighting control into one system, except for areas controlled by a single motion sensor such as rooms with a single luminaire and emergency

fixtures designed to operate 24/7. Distributed lighting control shall be provided using a networked micro relay panel. A centralized relay panel shall control corridors and site lighting. Lighting control system shall include all hardware and software. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the master LCP and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system shall have server built into the master LCP that "serves" HTML pages to any authorize workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital, non-server capable systems not acceptable.

- A. System software shall provide real time status of each relay, each zone and each group.
- B. Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line all system programming uploaded to the lighting control system shall continue to operate as intended. Systems requiring an on line PC or server for normal operation are not acceptable
- C. All devices shall be pre-addressed at the factory. Field addressing is not acceptable.
- D. All programs, schedules, time of day, etc, shall be held in non-volatile memory for a minimum of 10 years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.
- E. System shall be capable of flashing lights Off/On any relay or any zone prior to the lights being turned Off. The warning interval time between the flash and the final lights off signal shall be definable for each zone. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and not exceed 2-hours.
- F. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, specification grade line voltage type wall switches, photocell, web based software or other devices connected to programmable inputs in a lighting control panel.
- G. The lighting control system shall provide the ability to control each relay and each relay group per this specifications requirement. All programming and scheduling shall be able to be done locally at the master LCP and remotely via dial up modem and via the Internet. Remote connection to the lighting control system shall provide real time control and real time feedback.
- H. System may consist of centralized relay panels, micro relay panels, smart breaker panels, digital switches, photocells and various digital interfaces. Verify exact components specified. Micro relay panels, smart breaker panels, centralized relay panels and digital switches shall communicate as one network via RS485. Micro relay panels, mounted in each local area, per plans shall control all lighting fixtures in that space, provide power to occupancy sensors and take input from daylight sensor and occupancy sensors. Micro relay panels shall be capable of taking inputs from standard, line voltage type switches and outputting up to 8 independent 0v to 10v dimming signals. All micro relay panels and all devices connected to micro relay panels (switches, photocells and occupancy sensors, etc) shall be wired per lighting control manufacturers instructions.
- I. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

2.3 RELAY PANELS

- A. NEMA rated enclosure with screw cover or hinged door. Other NEMA types optional.
- B. 16 AWG steel barrier shall separate the high voltage and low voltage compartments of the panel and separate 120v, 277v and emergency circuits.
- C. LCP input power shall be capable of accepting 120v or 277v without rewiring
- D. Control electronics in the low voltage section shall be capable of driving 2 to 48, 30a, 18,000 SCCR rated latching relays, control any individual or group of relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each relay and every zone, and be able to control relays that default to Open, Normally Open Latching (NOL) or relays that default to Closed, Normally Closed Latching (NCL).
- E. Lighting control system shall be digital and consist of a Master LCP, Slave LCPs, Micro LCPs with up to 8 individual relays, digital switches, digital interface cards and if required, SmartBreaker panelboards. All system components shall connect and be controlled via a single Category 5, 4 twisted pair cable with RJ45 connectors, providing real time two-way communication with each system component. Analog systems are not acceptable.
- F. The lighting control system is a networked system that communicates via RS485 and includes centralized relay panels, micro relay panels, digital switches, photocells, various interfaces and operational software. The intent of the specification is to integrate all lighting control into one system. Lighting control system shall include all hardware and software. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the DTC and remote access to all programming functions via dial up modem and through any standard computer workstation running an industry standard internet browser. Lighting control system shall have server built into the master LCP that "serves" HTML pages to any authorized workstation. Desktop computers are not part of this section and will be provided by others. Non-networked, non-digital system not acceptable.

2.4 DALI SOLUTIONS

PRODUCT DATA SHEET 1 - MANUFACTURERS

- 2.1 Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products of Crestron Electronics, Inc., Rockleigh, NJ 07647, Phone (855) 644-7643, www.crestron.com

PRODUCT DATA SHEET 2 - Where indicated on the Contract Drawings, areas shall have all necessary parts, pieces and software for a fully turnkey DALI solution. System components shall comply with IEC 60929, Annex E, and IEC 62386 for DALI lighting control devices, wiring, computer hardware and software. Solution shall include but not be limited to:

- 2.1 Individually addressable electronic drivers/ballasts on the digital DALI bus. Drivers shall be able to receive commands and respond with status.
- 2.2 Sensors and user interfaces shall not reside on the DALI bus. These accessories shall be networked to the DALI interface controller as part of the turnkey solution. Reference specifications hereto after for more details on sensor and user interface selections that shall be compatible with the turnkey DALI solution.
- 2.3 [The DALI bus shall be class 1 (2) #12 THHN or larger and shall run with branch circuits in raceway per SS 26 05 33.
- 2.4 Each space shall be configured to have a minimum (1) group for all luminaires, and (1) group for each zone of fixtures as shown on the drawings.
- 2.5 A DALI interface controller shall be provided
 - A. Interface shall control minimum (2) DALI loops (128 DALI addresses)
 - 1. Contractor shall load the DALI loops to no more than 58 addresses at time of construction.
 - B. DIN 43880 form factor occupying not more than 9 DIN modules.
 - C. When replacing a single addressed luminaire, DALI re-addressing shall not require re-programming.
 - D. Mounts in NEMA 1 metal enclosure.
 - 1. Product: Crestron DIN-EN
 - E. Override port shall open the DALI bus forcing all drivers/ballasts to emergency preset light level (100% ON).
 - F. DALI interface shall be commissionable from USB/Ethernet from a PC or from a lighting control touch screen. Software shall allow for configuration of driver properties, groups and scenes.
 - G. Product: Crestron DIN-DALI-2

2.6 STANDARD OUTPUT RELAYS

- A. UL Listed 30 Amp, Latching, 18,000 SCCR, 277VAC Ballast and HID and 20 Amp Tungsten at 120 Vac.
- B. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two (2) #8AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.
- C. Relays to be rated for 250,000 operations minimum at a full 30a lighting load, default to closed at normal power loss, Normally Closed Latching (NCL). All incandescent circuits shall be energized by use of a Normally Closed SoftStart™ (NCSS) relay rated at 100,000 operations at full 20a load. No exceptions.

- D. Optional relay types available shall include: Normally Open Latching (NOL) relay rated for 250,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

2.7 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
 - 1. Match color specified in Division 26 Section "Wiring Devices."
 - 2. Integral green LED pilot light to indicate when circuit is on.
- B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."
- C. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."
- D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.
- E. All switches shall be digital and communicate via RS 485. Contact closure style switches, except as specified for connection to the micro relay panel matrixed contact closure inputs, shall not be acceptable. The programming for a digital switch will reside in the switch itself, via double EPROM memory. Any digital switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.
- F. Digital low voltage switch shall be a device that sits on the lighting control system bus. Digital switch shall connect to the system bus using the same cable and connection method required for relay panels. System shall provide capability to locally and remotely program each individual switch button, monitor and change function of each button locally and remotely. Each button shall be capable of being programmed for On only, Off only, On/Off (toggle), Raise (Dim up) and Lower (Dim down). Switches shall also be capable of being disabled for specified times. Switches requiring low voltage control wires to be moved from one input terminal to another to accomplish these functions are not acceptable.
- G. Digital switches for high abuse areas (common areas, atrium, etc.) shall be vandal resistant, contain no moving parts, and be touch sensitive and available with up to three buttons in a single gang. Multi gang versions shall also be available. Touch pads shall be Stainless Steel and capable of handling both high abuse and wash down locations. High abuse switches shall connect to the lighting control system digital bus. Each high abuse switch touch button shall be able to be control any relay or any group in any panel or panels that is part of the lighting control system. Each touch button shall be able to be programmed for On, Off, Toggle or Maintain operation. All programming shall be done locally or remotely via dial up modem or web interface as described in other paragraphs of this section. High abuse switches shall be able to be enabled or disabled digitally. Each touch pad is to be identified as to function by an engraved label. Switches must be capable of handling electrostatic discharges of at least 30,000 volts (1cmspark) without any interruption or failure in operation.

2.8 DTC - Digital Electronic Time Clock

- A. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept interface inputs.

- B. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.
- C. The DTC shall be capable of controlling up to 126 digital devices on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.
- D. The DTC shall accept control locally using built in button prompts and use of a 8 line 21-letter display or from a computer or modem via an on-board RS 232 port. All commands shall be in plain English. Help pages shall display on the DTC screen.
- E. The DTC shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 15 years with loss of power.
- F. Pre-installed Unity™ lighting control software shall provide via local or remote PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. System shall be capable of running optional Unity GX lighting control software, which shall provide for directly importing vector based graphics. No exceptions.
- G. Pre-Installed modem that allows for remote programming from any location using a PC. Modem to include all necessary software for local or remote control.
- H. DTC shall provide system wide timed overrides. Any relay, group or zone that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.

2.9 PHOTOCELL

- A. Photocells to be mounted in location indicated on the plans. Photocells used for exterior lights shall provide multiple trips point from 1 roof mounted unit. All trips points shall be able to be changed remotely via Internet or dial up modem. Photocells requiring manual trip point adjustment are not acceptable. Photocell used for interior lighting control shall have multiple settings such as start-point, mid-point, off-point, fade-up, fade-down, etc. All settings shall be remotely accessible and adjustable. Systems providing local adjustment only are not acceptable. Photocells to be certified to comply with the current energy code covering this project at time of submittal of plans for building permit.

2.10 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 16 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5 for horizontal copper cable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panels according to NECA 407.
- B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway except in unfinished spaces. Minimum conduit size shall be ½ inch.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for cable trays specified in Section 26 0536 "Cable Trays for Electrical Systems."
 - 3. Comply with requirements for raceways and boxes specified in Section 26 0533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 PANEL INSTALLATION

- A. Comply with NECA 1.
- B. Install panels and accessories according to NECA 407.
- C. Mount panel cabinet plumb and rigid without distortion of box.
- D. Install filler plates in unused spaces.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 0553 "Identification for Electrical Systems."

- C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.
- D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
- E. Provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate exact mounting location of each system device. This accurate "as built" shall indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Original to be given to owner, copies placed inside the door of each LCP.

3.5 INSTALLATION AND SET-UP

- A. Verify that conduit for line voltage wires enters panel in line voltage areas and conduit for low-voltage control wires enters panel on low-voltage areas. Refer to manufacturer's plans and approved shop drawings for location of line and low-voltage areas. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product acceptability.
- B. For approved line voltage type micro relay panel switches connected to matrixed inputs of the micro relay panel, furnish #18 AWG solid conductors. For all other digital switches provide wiring required by system manufacturer.
- C. For classroom digital switches provide wiring required by system manufacturer
- D. Contractor to test all low voltage cable for integrity and proper operation prior to turn over. Verify with system manufacturer all wiring and testing requirements.
- E. Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, commissioning of the lighting control system, and Owner instruction includes:
 - 1. Confirmation of entire system operation and communication to each device.
 - 2. Confirmation of operation of individual relays, switches, occupancy sensors and daylight sensors
 - 3. Confirmation of system Programming, photocell settings, override settings, etc.
 - 4. Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.
- F. Panels shall be located so that they are readily accessible and not exposed to physical damage.
- G. Panel locations shall be furnished with sufficient working space around panels to comply with the National Electrical Code.
- H. Panels shall be securely fastened to the mounting surface by at least 4 points.
- I. Unused openings in the cabinet shall be effectively closed.
- J. Cabinets shall be grounded as specified in the National Electrical Code.
- K. Lugs shall be suitable and listed for installation with the conductor being connected.

- L. Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
- M. Maintain the required bending radius of conductors inside cabinets.
- N. Clean cabinets of foreign material such as cement, plaster and paint.
- O. Distribute and arrange conductors neatly in the wiring gutters.
- P. Follow the manufacturer's torque values to tighten lugs.
- Q. Before energizing the panelboard, the following steps shall be taken:
 - 1. Retighten connections to the manufacturer's torque specifications. Verify that required connections have been furnished.
 - 2. Remove shipping blocks from component devices and the panel interior.
 - 3. Remove debris from panelboard interior.
- R. Follow manufacturers' instructions for installation and all low voltage wiring.
- S. Service and Operation Manuals:
 - 1. Submit operation and service manuals. Complete manuals shall be bound in flexible binders and data shall be typewritten or drafted.
 - 2. Manuals shall include instructions necessary for proper operation and servicing of system and shall include complete wiring circuit diagrams of system, wiring destination schedules for circuits and replacement part numbers. Manuals shall include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built coding used on cables. Programming forms of systems shall be submitted with complete information.
- T. Comply with energy code lighting control system "Acceptance Requirements". Acceptance tests are used to verify that lighting controls were installed and calibrated correctly. These tests may require that a responsible party certify that controls are installed and calibrated properly. This is the installing contractors responsibility. Verify requirements with building authority.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:
 - 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. Acceptance Testing Preparation:
 - 1. Test continuity of each circuit.
- D. Lighting control panel will be considered defective if it does not pass tests and inspections.

- E. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.
- B. Provide factory-authorized personal for the following lighting control services:
 - 1. Provide programming time including feedback and site visit with Owner present to program the zones and times with owner input. Notify Engineer what date and time is set up for programming session for optional attendance.
 - 2. Provide lighting controls on-site commissioning and coordination with electrical contractor after initial programming and before building is occupied.
 - a. Provide at least 3 days for a building less than 30,000 square foot.
 - b. Provide at least 5 days for a building less than 200,000 square foot.
 - 3. Provide up to (8) hours of owner training with Owner present.
 - 4. Provide additional time after substation completion and within 30 days of owner Final Acceptance to make one-set of Owner requested changes.

3.8 ADJUSTING

- A. Owner Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in programming scheduling, dimming and adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- B. Occupancy sensors shall be adjusted for seamless operation, contractor will have to move sensor and adjust settings at no charge due to faulty operation of the sensor due to location or settings for up to 12 months from date of Substantial Completion.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 0943

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Wall-box motion sensors.
 - 3. Snap switches and wall-box dimmers.
 - 4. Communications outlets.
- B. See Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION 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.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 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 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Wiring Devices:
 - a. Cooper Wiring Devices
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Mfg. Company Inc.
 - d. Pass & Seymour/Legrand; Wiring Devices Div.
 - e.
2. Poke-Through, Floor Service Outlets and Telephone/Power Poles:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Pass & Seymour/Legrand; Wiring Devices Div.
 - c. Square D/Groupe Schneider NA.
 - d. Wiremold Company (The).
 - e. Steel City/Thomas and Betts / A Member of the ABB Group.

2.2 RECEPTACLES

- A. All devices shall be heavy duty tamper resistant type..

2.3 SWITCHES

- A. Single and Multi-pole Switches: Comply with UL20.
- B. Snap Switches: 20A, 120/277 volt, AC, heavy-duty grade, quiet type.
- C. Keyed Switches: 20A, 120/277 volt, AC, heavy-duty grade, quiet type.
 1. Provide two keys for each keyed switch installed on project. Turn-over keys to owner at time of Substantial Completion.

2.4 DEVICE 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: 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel. Color shall match device color.
 3. Material for Unfinished Spaces: Galvanized steel.. Color shall match wiring device color.
 4. Provide device plates for all power and data outlets.

2.5 WET LOCATION RECEPTACLE COVERS

- A. Wet Location Receptacle Covers: Receptacles located outdoors or those indicated as weatherproof shall be equipped with covers that maintain the NEMA 3R weatherproof integrity when attachment plug caps are inserted.
 1. Covers shall be die cast aluminum with powder coat finish, UL listed and comply with NEC.
 2. Covers shall be:
 - a. Tay Mac Corporation # MX3200

- b. Red Dot #CKSUV

2.6 POKE-THROUGH ASSEMBLIES

- A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
1. Size: Selected to fit nominal 3 inch (75 mm) cored openings in floor and matched to floor thickness.
 2. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 3. Closure Plug: Arranged to close unused 3 inch cored openings and reestablish fire rating of floor.
 4. Wiring: Three No. 12 AWG power and ground conductors; one 75 ohm coaxial telephone/data cable; and one four-pair, 75 ohm telephone/data cable.

2.7 MULTIOUTLET ASSEMBLIES

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish.
- C. Wire: No. 12 AWG.

2.8 WIRING DEVICE AND COVER FINISHES

- A. Stainless:
1. Covers to be stainless steel with white devices.

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. Install devices and assemblies level, plumb, and secure.
 2. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 3. 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.
 4. 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.
 5. 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. Pigtailing 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 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. Provide an individual GFCI receptacle for each one shown on the drawings. Do not feed downstream receptacles on the same circuit using the protection of a GFCI receptacle.
11. Where GFCI receptacles are concealed behind either fixed or removable equipment, provide remote GFCI test device per NFPA-70 requirements.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

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.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

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.

3.3 CONNECTIONS

- A. Connect receptacles using screw-compression wiring contacts or pigtail leads. Do not use push-in contacts.
- B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
- C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.
- D. 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.

3.4 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.
- B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- C. Remove damaged and defective components.

3.5 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 2726

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SECTION 26 2913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.
 - 3. Multispeed.

1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.7 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.8 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. Spare Fuses: Furnish quantity equal to 10 percent of each type and size installed, but not less than one set of three of each type and rating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Manual and Magnetic Enclosed Controllers:
 - a. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - b. Eaton Corp.; Cutler-Hammer Products.
 - c. General Electrical Distribution & Control.
 - d. Rockwell Automation Allen-Bradley Co.; Industrial Control Group.
 - e. Siemens Energy & Automation, Inc.
 - f. Square D; a brand of Schneider Electric.

2.2 MANUAL ENCLOSED CONTROLLERS

- A. Description: NEMA ICS 2, general purpose, Class A, for use with fractional horsepower, single phase motors.
 - 1. Quick-make, Quick-break toggle switch.

2. Melting-alloy type thermal overload relay. Heaters matched to nameplate full-load current of actual protected motor; external reset push button
3. LED Pilot light.
4. Flush mounting, stainless steel plate for use in finished rooms. Surface mounting, standard enclosure for use in utility and mechanical rooms.
5. Provide with handle guard/lock-off feature.
6. Provide NEMA type 1, type 3R or type 4 as appropriate for location.

2.3 MAGNETIC ENCLOSED CONTROLLERS

- A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
- B. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Minimum transformer capacity 100 VA.
- C. Combination Controller: Factory-assembled combination controller and disconnect switch.
 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory. Lockable Handle which accepts three padlocks and interlocks with cover in closed position.
 2. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes. Lockable Handle which accepts three padlocks and interlocks with cover in closed position.
- D. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- E. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
 1. Compelling relay to ensure motor will start only at low speed.
 2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
 3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.4 ENCLOSURES

- A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 1. Dry and Clean Indoor Locations: Type 1
 2. Outdoor Locations: Type 3R.
 3. Kitchen and Wash-Down Areas: Type 4X, stainless steel.
 4. Other Wet or Damp Indoor Locations: Type 4.
 5. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES

- A. Push Buttons, Pilot Lights, and Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.
- B. Control Relays: Auxiliary and adjustable time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

2.6 FACTORY FINISHES

- A. Manufacturer's standard finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height, and with disconnect operating handles not higher than 72 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5.
- C. Provide a manual motor controller for all 120 volt motors shown on the mechanical plans.
- D. Install fuses in each fusible-switch enclosed controller.

- E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- F. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified 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 nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment.
- 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.

3.6 ADJUSTING

- A. Set field-adjustable switches, overload-relay pickup, and trip ranges.
- B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start

motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

3.7 CLEANING

3.8 Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 26 2913

SECTION 26 2923 - VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Wiring for variable frequency controllers (VFC) that are provided by Division 23 for mechanical equipment.
- B. Refer to various Division 23 sections for controller requirements furnished with equipment.

1.2 REFERENCES

- A. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems; National Electrical Manufacturers Association; 1995.
- B. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives; National Electrical Manufacturers Association; 1993.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 1997.
- D. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.3 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 220, 250, and 430, as applicable to installation, and construction of motor controllers.
- C. UL Compliance: Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide materials which are UL-listed and labeled.
- D. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, and Pub No. 250, pertaining to motor controllers and enclosures.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide wiring of VFC's where indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL and NEMA standards, to ensure that products fulfill requirements.
- B. Provide the following power wiring and conduit.
 - 1. Wiring from MCC/power panel to drive.
 - 2. Wiring of line reactor and other any other accessories.
 - 3. Wiring from drive to motor (including wiring to near motor disconnect switch if included).
 - 4. The inter-wiring indicated above shall be provided by the contractor at no additional cost regardless of how the connection is shown diagrammatically on the floor plans or one-line.
- C. Provide control wiring and conduit between drive and smoke detectors or fire alarm panel. Provide any required relays for shutdown of multiple drives.
- D. Electrical Wiring: Electrical wiring and connections are specified in Division 26.
- E. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections.

END OF SECTION 26 2923

SECTION 26 5100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, LED modules and drivers.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
3. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.2 ACTION SUBMITTALS

- A. General: Some lighting fixtures may require at least 3 to 4 months of lead time. The Contractor is responsible for allowing sufficient time for the review process, manufacturing and delivery of these products. Substitutions will not be accepted on the basis of the Contractor's obligation to meet project completion deadlines.
- B. Lighting Fixtures Specified: The lighting fixtures specified in these documents have been carefully chosen for their ability to meet lighting requirements for this project. Selection has been based on esthetics, durability, ease of maintenance, luminance ratios, vertical and horizontal illuminances, lumen maintenance, CRI, efficacy, LED system life and warranty as well as their ability to satisfy governing codes such as ASHRAE/IES 90.1/1999. The Contractor is cautioned that substitute products are likely to be unable to meet all of the same criteria as the product specified.
- C. Substitutions: When proposing substitute products, the Contractor shall be responsible for the negotiation with the Owner and Architect/Engineer, prior to substitution submittal, to assure fees are available to redesign the project based on the proposed substitutions or review by the Architect/Engineer of all photometric, sample, design and calculations for the proposed substitutions. All substitutions must be identified at time of bid. The Contractor's bid value shall not be based on substitutions in expectation of design team approval, nor on the Contractor's estimated value of the products specified. If review of the proposed substitute light fixtures finds the product unacceptable, the Contractor shall provide the fixtures specified at no additional cost to the Owner or delay in the project completion time.
- D. Product Data: For each type of lighting fixture and lamp indicated, arranged in order of fixture designation. Submit fixture data in bound brochure. Include illustrations and dimensions of fixtures, and showing photometric performance. Include data on features, accessories, and the following:
1. Contract Drawing light fixture type designation.

2. Dimensions of fixtures.
 3. Certified results of independent laboratory tests of fixtures and lamps for electrical ratings and photometric data.
 4. Emergency lighting unit battery and charger.
 5. LED fixture LM79, LM80 and TM21 testing data.
 6. Written Warranty Compliance
- E. Lighting Fixture Submittals: Fixture cuts lacking sufficient detail to indicate compliance with specifications will not be acceptable.
- F. Shop Drawings: Show details of nonstandard and custom fixtures. Indicate dimensions, weights, components, features, accessories, and methods of field assembly and mounting.
1. Wiring Diagrams: Detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.
- G. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 01.

1.3 QUALITY ASSURANCE

- A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with NFPA 70.
- C. Comply with LM 79, LM80 and TM21 LED testing standards.
- D. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.
- E. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.
- F. Office of Fire Safety: All plastic diffusers used in lighting fixtures or luminous ceilings shall conform with NFPA 101, Life Safety Code, 1997 Edition, Section 6-5, Interior Finish. The light fixture manufacturer(s) shall furnish an affidavit stating compliance with this requirement for submittal to the State of Michigan Department of Labor & Economic Growth, Office of Fire Safety, P.O. Box 30254, Lansing, Michigan 48909.

1.4 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.5 WARRANTY

- A. Special Warranty for Batteries: Written warranty, executed by manufacturer agreeing to replace rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Batteries: Manufacturer's standard, but not less than 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for last nine years.
- B. Warranty for LED fixtures: Written warranty, agreeing to replace drivers, LED modules and any fixture housing or components that fail in materials and workmanship within minimum (5) years from date of purchase. Warranty shall provide materials necessary to restore to acceptable operation. Labor shall be warrantied for two years of the project substantial completion. The warranty shall include fixture replacement or component replacement if the luminaire delivers less than 90% of the initial light level over the rated life.
 1. For decorative pendant and track fixtures, warranty shall be minimum of (5) years.
 2. All other fixtures shall match the standard warranty of the fixture specified.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURE MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Lighting Fixture Schedule on the plans.

2.2 EXIT SIGNS

- A. General Requirements: Comply with UL 924 and the following:
 1. Refer to Lighting Fixture Schedule on the plans.
- B. Internally Lighted Signs: Features as follows:
 1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 1. Battery: Sealed, maintenance-free, nickel-cadmium type.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically energizes lamp from unit when circuit voltage drops to 80 percent of nominal or below. When normal voltage is restored, relay disconnects lamps, and battery is automatically recharged and floated on charger.
- D. Wire Guard: Provide heavy chrome plated wire guards to protect fixtures installed in gymnasiums and multi-purpose rooms.

2.3 FINISHES

- A. Fixtures: Manufacturer's standard, unless otherwise indicated.
 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
 2. Metallic Finish: Corrosion resistant.

2.4 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Interior Lighting Systems shall be installed in accordance with NECA/IESNA 500, Recommended Practice for Installing Indoor Commercial Lighting Systems and NECA/IESNA 502-2011, Recommended Practice for Installing Industrial Lighting Systems.
- B. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials.
- C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Support fixture using grid plus the following:
 - 1. Fixtures shall be positively attached to the ceiling grid system.
 - 2. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
 - 3. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
 - 4. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently of panel, with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- D. Suspended Fixture:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with two separate stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing, stem, or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings.

5. Fixtures to be aligned and level, insure lenses are fastened properly in place.
 6. Any supports used to suspend fixture in exposed ceiling areas shall be installed as high as possible out of view and painted with ceiling.
 7. Mount remote type drivers out of site above ceilings or in painted enclosure.
- E. In Mechanical and Boiler Rooms, coordinate lighting fixture installation with mechanical piping, duct work, etc. Provide all required supporting rods and channel to bridge duct work and piping. Generally, mount fixtures 8-9 feet above floor unless noted otherwise. Avoid positioning above mechanical piping and ducts.

3.2 CONNECTIONS

- A. Ground equipment.
1. Tighten electrical connections 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.

3.3 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Provide instruments to make and record test results.
- C. Tests:
1. Verify normal operation of each fixture after installation.
 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
 3. Verify normal transfer to battery source and retransfer to normal.
- D. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units are acceptable.
- E. Corroded Fixtures: Replace during warranty period.

3.5 STARTUP SERVICE

- A. Burn-in all fixtures that require specific aging period to operate properly, prior to occupancy by Owner.

3.6 CLEANING AND ADJUSTING

- A. Clean fixtures internally and externally after installation. Fixture cones, reflectors, baffles, and visible trim shall be turned over to the owner clean and free of dust, drywall mud, smudges, fingerprints, and scratches. Only use methods and cleaning materials in accordance with respective fixture manufacturer recommendations.
- B. All adjustable light fixtures shall be aimed, focused and locked by the Contractor under the observation of the Architect/Engineer. When daylighting interferes with the aiming and focusing, aiming shall be accomplished during hours of darkness.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
 - 1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 26 5100

SECTION 27 0500 – COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 Documents

- A. This section of the of the specification is part of the contract documents and is to be read, interpreted and coordinated with all other parts.

1.2 Summary

- A. Section Includes:
 - 1. Overview
 - 2. Abbreviations
 - 3. Contractor Qualifications
 - 4. Standards and Guidelines
 - 5. Quality Assurance
 - 6. Permits and Inspections
 - 7. Low Voltage Cable Bundling

1.3 Overview

- A. This document must be read, interpreted and coordinated with all other related specifications to deliver a complete Telecommunications infrastructure system.
- B. This specification prescribes mandatory requirements for the Telecommunications infrastructure system.
- C. A structured approach is specified which will ensure a flexible distribution system that will minimize the future costs of moves, additions and changes.
- D. The Contractor will supply, furnish, and install all material, labor, tools, equipment and services required for construction and put into regular operation the complete Telecommunications system as shown on the Telecommunications drawings, described in the specifications, and any attached appendices.
- E. Any and all proposed changes to this specification shall be subject to approval in writing to the Architect prior to implementation.

1.4 Abbreviations

- A. 8P8C: 8-position, 8-contact
- B. ANSI: American National Standards Institute
- C. ASTM: American Society for Testing and Materials
- D. 10Gig: 10-Gig Active Ethernet

- E. 10GPON: 10-Gigabit Symmetrical Passive Optical Network
- F. A/V: Audio Visual
- G. AC: Alternating Current
- H. AHJ: Authority Having Jurisdiction
- I. APC: Angled Physical Contact
- J. BICSI: Building Industry Consulting Service International.
- K. Coated RMC: PVC Coated Rigid Metallic Conduit
- L. DC: Direct Current
- M. EF: Entrance Facility
- N. EIA: Electronic Industries Alliance
- O. EMI: Electromagnetic Interference
- P. EMT: Electrical Metallic Tubing
- Q. ENT: Electrical Non-metallic Tubing
- R. ER: Equipment Room
- S. GRC: Galvanized rigid steel conduit
- T. IDF: Intermediate Distribution Frame
- U. IP: Internet Protocol
- V. IMC: Intermediate metal conduit
- W. LAN: Local Area Network
- X. MDF: Main Distribution Frame
- Y. MPTL: Modular Plug Terminated Link
- Z. NTP: Network Time Protocol
- AA. OSP: Outside Plant Wiring
- BB. PDU: Power Distribution Unit
- CC. PoE: Power over Ethernet
- DD. RCDD: Registered Communications Distribution Designer (BICSI)

- EE. RGS: Rigid Galvanized Steel
- FF. RU: Rack Unit
- GG. SFP: Small Form Pluggable
- HH. SMF: Single Mode Fiber
- II. STP: Shielded Twisted Pair
- JJ. TDM: Telecommunications Distribution Methods Manual (BICSI)
- KK. TECH: Technician (BICSI Certified)
- LL. TI: Technology Integrator
- MM. TIA: Telecommunications Industry Association
- NN. TR: Telecommunications Room
- OO. UL: Listed by Underwriters Laboratories (United States)
- PP. UPC: Ultra Physical Contact
- QQ. UPS: Uninterruptable Power Supply
- RR. UTP: Unshielded Twisted Pairs
- SS. WAO: Work Area Outlet
- TT. WAP: Wireless Access Point

1.5 Contractor Qualifications

- A. The Contractor will have experience in the installation and testing of similar systems as specified herein and will have completed at least two projects of similar size and scope within the last 24 months. The contractor will provide references upon request (including the project name, address, date of implementation, client name, title, telephone number and project description).
- B. All members of the installation team must be certified by the Manufacturer as having completed the necessary training to complete their part of the installation. All personnel will be adequately trained in the use of such tools and equipment as required.
- C. The Contractor must be certified to install a certified fire-stop system.
- D. The Contractor will own and maintain tools, installation equipment, and test equipment necessary for successful installation and testing of optical and Category 6 and 6a premise distribution systems.
- E. The Contractor must maintain a state Contractor's license as required by the state.

- F. The Contractor installing the structured cabling shall have a Registered Communication Distribution Designer (RCDD) as a Project Superintendent.
- G. The Contractor's lead installer shall have a current BICSI TECH certification and shall be onsite for the duration of the project.

1.6 Standards and Guidelines

- A. The following organizations publish telecommunications construction standards with provisions that, through reference in this text, constitute provisions of this Document. At the time of publication of this Document, the editions of the standards published by the organizations indicated were valid. Installers of telecommunications and networking services for this project must adhere to the telecommunication standards published by these organizations, all standards are subject to revision; parties to agreements based on this Document shall apply the most recent editions of the standards published by the organizations indicated.

- 1. Federal Communications Commission (FCC)
- 2. Institute of Electrical and Electronics Engineers, Inc (IEEE)
- 3. National Fire Protection Association (NFPA)
- 4. National Electrical Safety Code (NESC)
- 5. American National Standards Institute (ANSI)
- 6. Telecommunications Industry Association (TIA)
- 7. Electronic Industries Alliance (EIA)
- 8. Building Industry Consulting Service International (BICSI)

- B. Applicable Standards and Guidelines

- 1. The following list of methods and standards included are considered part of this specification. This is a list of primary references and does not limit the applicability of other standards that are incorporated into the work described in these specifications. They incorporate generally accepted communications infrastructure practices described in Standards documents (and addenda) published by recognized standards bodies and organizations. These include standards published by the Telecommunications Industry Association/Electronics Industries Alliance (TIA/EIA) and Building Industry Consultant Services International (BICSI).
 - a. ANSI/TIA/ EIA 568B, Commercial Building Telecommunications Cabling Standard. This prescribes the requirements for Intrabuilding copper and optical fiber cable performance, installation and testing
 - b. ANSI/TIA/EIA 569B, Telecommunication Standard for Pathways and Spaces. This standard includes specifications for the design and construction of pathways and spaces within buildings required to support information technology equipment and cable media.
 - c. ANSI/TIA/EIA 607, Commercial Building Grounding and Bonding Requirement. This document includes the components of an effective grounding system for communication systems within public and commercial buildings.
 - d. ANSI/TIA/EIA 758, BICSI Customer Owned Outside Plant Telecommunications Cabling
 - e. Standard. This standard provides specifications for Interbuilding communication facilities that
 - f. include cable media, pathways and spaces.
 - g. ANSI/TIA/EIA 862, Building Automation Systems Cabling Standard for Commercial Buildings. This standard describes the generic cable system for building automation systems (BAS) that are intended to support a multi-product, multi-vendor automation environment within public and commercial buildings.

- h. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual, 14th Edition. This is a manual of proven design guidelines and methods accepted by the telecommunications industry.
- i. ANSI/NFPA 70, National Electrical Code, (NEC) Current Edition. In addition to standards related to electrical safety, the NEC has several sections that specifically address low voltage cable installation.

1.7 Quality Assurance

- A. The latest National Electrical Code shall be observed and shall govern the character of work, style, quantity and the size of all material used.
- B. All materials shall conform with the standards of the Underwriter's Laboratories in every case where such standards have been established for the particular type of material in question.
- C. All material and equipment shall be UL listed and bear the UL label where such listing and labeling exists.
- D. The complete electrical installation shall comply with all the requirements of the MI.O.S.H.A.
- E. Codes shall be used as minimum requirements, and where the Specifications or Plans call for an installation that exceeds and does not violate the Code requirements, the Specifications and Plans shall be followed.

1.8 Permits and Inspections

- A. The Contractor shall obtain and pay for all permits required by the State of Michigan Labor Department, Electrical Division.
- B. The Contractor shall submit, to precede request for final payment, a copy of the Certificate of Inspection as required by the State of Michigan.

1.9 Low Voltage Cable Bundling

A. Cable Ties

- 1. Cable ties shall not be allowed for the final bundling of data, security and audio/video cables.
 - a. Cable ties can be used on a temporary basis during cable installation.
 - b. All cable ties shall be removed after temporary use.
 - c. All temporary zip ties shall be plenum rated, where required.

B. Hook and Loop

- 1. Hook & Loop (also known as Velcro) shall be used in final data, security and audio/video cable installations.
 - a. All low voltage cables shall be bundled neatly using hook & loop.
 - b. Hook & Loop shall be black except in exposed areas or otherwise noted in drawings and/or specifications.
 - c. The Hook & Loop color in exposed areas shall be approved by Architect prior to installation.
 - d. All Hook & Loop shall be a minimum of $\frac{3}{4}$ " in width.
 - e. All Hook & Loop shall be plenum rated, where required.

PROJECT NO. 23-612.00
KPS LOY NORRIX HIGH SCHOOL HEALTH SUITE
KALAMAZOO PUBLIC SCHOOLS

COMMON WORK RESULTS FOR COMMUNICATIONS
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END OF SECTION 27 0500

SECTION 27 0526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.2 STANDARDS

A. Comply with TIA-607-D.

1. At the time of publication of this Document, the editions of the standards published by the organization were valid. Installers of telecommunications and networking services for this project must adhere to the telecommunication standards published by this organization, all standards are subject to revision.

1.3 DEFINITIONS

- A. TBC: Telecommunications Bonding Conductor
- B. SBB: Secondary Bonding Busbar
- C. PBB: Primary Bonding Busbar
- D. BBC: Bonding Backbone Conductor
- E. RBB: Rack Bonding Busbar

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Installer Credentials:

1. BICSI TECH certification is required for the lead installer that will be onsite at all times.
2. Valid certificates shall be provided to TowerPinkster prior to project kick-off.

- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.
 - 1. As-built Drawings.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer shall have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by a BICSI TECH.
 - 2. Installation Supervision: Installation shall be under the direct supervision of a BICSI TECH, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as a TECH to supervise on-site testing.

1.8 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Harger Lightning and Grounding.
 - 2. Panduit Corp.
 - 3. Chatsworth Products
- B. Comply with UL 486A-486B.
- C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
- D. 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 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 GROUNDING CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Burndy; Part of Hubbell Electrical Systems.
 2. Chatsworth Products, Inc.
 3. Harger Lightning and Grounding.
 4. Panduit Corp.
- C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 1. Electroplated tinned copper, C and H shaped.
- D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING BUSBARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Chatsworth Products, Inc.
 2. Harger Lightning and Grounding.
 3. Panduit Corp.
- B. PBB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as PBB and shall comply with TIA-607-C.
 1. Predrilling shall be with holes for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide a 2-inch
 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. SBB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-C.

1. Predrilling shall be with holes for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch
 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-C. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 3. Rack-Mounted Vertical Busbar: 72 or 36 inches stainless-steel or copper-plated hardware for attachment to the rack.

2.4 GROUND RODS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Harger Lightning and Grounding.
 2. Erico
- B. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet in diameter.

2.5 GROUNDING LABELING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brother International Corporation.
 2. Dymo.
 3. Panduit Corp.
- B. Comply with TIA-606-Band UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

- B. Inspect the test results of the ac grounding system measured at the point of TBC connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the TBC only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-C.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the SBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the PBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches
- E. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.
 - 4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

- a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 0528 "Pathways for Communications Systems," and bond both ends of the conduit to an SBB.

3.4 GROUNDING ELECTRODE SYSTEM

- A. The TBC between the PBB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

3.5 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, minimum 12 inches above finished floor unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the PBB with insulated bonding conductor.
- E. Interconnections: Interconnect all SBBs with the PBB with the telecommunications backbone conductor. If more than one PBB is installed, interconnect PBBs using the backbone bonding conductor. The telecommunications backbone conductor and backbone bonding conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG (168 kcmils) unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the SBB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each SBB to the ground bar of the panelboard.

- I. Shielded Cable: Bond the shield of shielded cable to the SBB in communications rooms and spaces. Comply with TIA-568.1-D and TIA-568-C.2 when grounding screened, balanced, twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors: Bond all metal parts of access floors to the SBB.

3.7 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label PBB(s) with "fs-PBB," where "fs" is the telecommunications space identifier for the space containing the PBB.
 - 2. Label SBBs) with "fs-SBB," where "fs" is the telecommunications space identifier for the space containing the SBB.
 - 3. Label the TBC and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and a SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 - 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable ac current level is 1 A.
- C. Excessive Ground Resistance: If resistance to ground at the TBC exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

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KALAMAZOO PUBLIC SCHOOLS

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

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END OF SECTION 27 0526

SECTION 27 0528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation of pathways as described on the Drawings and/or required by these specifications.
- B. Section Includes:
 - 1. Non-Continuous Cable Supports.
 - 2. Hook & Loop (Velcro)
- C. Related Requirements:
 - 1. Division 26 Section "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
 - 2. Division 28 Section "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.2 ACTION SUBMITTALS

- A. Non-Continuous Cable Supports
- B. Hook & Loop (Velcro)
 - 1. Refer to specification 27 500 COMMON WORK RESULTS FOR COMMUNICATIONS.

1.3 INFORMATIONAL SUBMITTALS

- A. Installer Credentials:
 - 1. BICSI TECH certification is required for the lead installer that will be onsite at all times.
 - 2. Valid certificates shall be provided to TowerPinkster prior to project kick-off.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.
 - 1. As-built Drawings.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer shall have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by a BICSI TECH.
 2. Installation Supervision: Installation shall be under the direct supervision of a BICSI TECH, who shall be present at all times when Work of this Section is performed at Project site.

PART 2 - PRODUCTS

2.1 NON-CONTINUOUS CABLE SUPPORTS

- A. General Requirements for non-continuous cable supports:
1. Shall be UL Listed
 2. Shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables per ANSI/TIA 568.0-D
 3. Shall have flared edges to prevent damage while installing cables Comply with TIA-569-D.
 4. Shall have a cable retainer wire form to provide containment of cables within the hanger. The cable retainer shall be removable and reusable.
 5. Shall have a hot-dipped galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
 6. Acceptable products: PENTAIR CADDY CAT32HP, CAT48HP, CAT64HP.
 7. Non-continuous cable supports shall be a minimum of 2-inches.

2.2 HOOK & LOOP (VELCRO)

- A. Refer to specification 27 500 COMMON WORK RESULTS FOR COMMUNICATIONS.

PART 3 - EXECUTION

3.1 INSTALLATION

1. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
2. Install cables using techniques, practices, and methods that are consistent with Category 5e or higher requirements and that supports Category 5e or higher performance of completed and linked signal paths, end to end.
3. Install cables without damaging conductors, shield, or jacket.
4. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer or by TIA 568.
5. Pull cables without exceeding cable manufacturer's recommended pulling tensions or outlined in TIA 569. Use pulling means that will not damage media.
6. Do not exceed load ratings specified by manufacturer.
7. Non-continuous supports shall be installed a minimum 3 inches above ceilings.

8. Non-continuous supports shall be installed so there is no more than 5ft between supports, measured horizontally.
- B. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Pathways Embedded in Slabs:
 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- H. Stub-ups to Above Recessed Ceilings:
 1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- J. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- K. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- L. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.
- M. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.

- N. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

3.2 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.3 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.

END OF SECTION 27 0528

SECTION 27 0553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Color and legend requirements for labels and signs.
 2. Labels.
 3. Fasteners for labels and signs.

1.2 ACTION SUBMITTALS

- A. Labels

1.3 INFORMATIONAL SUBMITTALS

- A. Installer Credentials:
1. BICSI TECH certification is required for the lead installer that will be onsite at all times.
 2. Valid certificates shall be provided to TowerPinkster prior to project kick-off.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer shall have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by a BICSI TECH.
 2. Installation Supervision: Installation shall be under the direct supervision of a BICSI TECH, who shall be present at all times when Work of this Section is performed at Project site.
 3. Testing Supervisor: Currently certified by BICSI as a TECH to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:

1. White letters on a Black field.

2.3 LABELS

A. Self-Adhesive Wraparound Labels: computer printed, 3-mil-thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Permanent, waterproof black ink marker recommended by tag manufacturer.
3. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
4. Handwritten labels are not approved.

B. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 FASTENERS FOR LABELS AND SIGNS

A. 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 and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Verify identity of each item before installing identification products.
- C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- D. Apply identification devices to surfaces that require finish after completing finish work.

- E. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- F. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- G. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label within 12 inches from each cable end.
- H. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

3.2 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
 - 1. System legends shall be as follows:
 - a. Telecommunications.
- D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
 - 1. Refer to detail drawings
- E. Equipment Room Labeling:
 - 1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 - 2. Patch Panels: Label individual rows and outlets, starting at top left and working down, with self-adhesive labels.
- F. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

1. Fiber optic cables shall be labeled on each end within 12 inches of where fiber cable enters enclosure.
- G. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
 1. Refer to detail drawings.
- H. Instructional Signs: Self-adhesive labels.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
 1. Apply to exterior of door, cover, or other access.
- J. Equipment Identification Labels:
 1. Indoor Equipment: Self-adhesive label.
 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
 3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.
 - c. Computer room air conditioners.
 - d. Fire-alarm and suppression equipment.
 - e. Egress points.
 - f. Power distribution components.

END OF SECTION 27 0553

SECTION 27 1513 – COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of copper horizontal cabling infrastructure as described on the Drawings and/or required by these specifications.
- B. Section Includes:
 - 1. CAT6 Cable.
 - 2. CAT6 Termination Hardware.
 - 3. CAT6 Patch Cables.
 - 4. Labeling.
 - 5. Certification Testing.
 - 6. As-Built Drawings.
 - 7. Grounding provisions for twisted pair cable.
 - 8. Cable Manufacturer Warranty

1.2 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568.2-D requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.3 ACTION SUBMITTALS

- A. Cabling Manufacturer Certified Installer Certificate
- B. CAT6 Cable
- C. CAT6 Termination Hardware

- D. CAT6 Patch Cables
- E. Shop Drawings: Reviewed by a current BICSI RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration Drawings and printouts.
 - 4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment.
- F. Twisted pair cable testing plan.

1.4 INFORMATIONAL SUBMITTALS

- A. Installer Credentials:
 - 1. Each installer is required to be certified by the manufacturer of the products that are installed (i.e. Panduit, Belden, Hubbell, Commscope)
 - 2. BICSI TECH certification is required for the lead installer that will be onsite at all times.
 - 3. Valid certificates shall be provided to TowerPinkster prior to project kick-off.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.
 - 1. As-built Drawings.
 - 2. Certification results for all installed cables (PDF & Certification tester format)
 - 3. Cabling Manufacturer Warranty Certificate

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer shall have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by a BICSI TECH.
 - 2. Installation Supervision: Installation shall be under the direct supervision of a BICSI TECH, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as a TECH to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency is required to have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as a TECH.

1.7 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568.1-D, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-E.
- C. Grounding: Comply with TIA-607-D.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications Plenum Rated: Type CMP complying with UL 1685.
 - 2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. RoHS compliant.

2.3 CAT6 CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 350MHz.
- B. Standard Compliances:
 - 1. ANSI/TIA 568.2-D
 - 2. NEC/CEC Type CMR (UL 1666) for Non-Plenum
 - 3. NEC/CEC Type CMP (NFPA 262) for Plenum
 - 4. UL Listed CMP-LP (0.5A) for Plenum
 - 5. UL 444
 - 6. RoHS Compliant Directive 2011/65/EU
 - 7. ANSI/TIA 862 (Building Automation)
 - 8. ICEA S-116-732
 - 9. ICEA S-102-700
 - 10. ISO/IEC 11801 Ed. 2.0 (Class E)
- C. Applications

1. IEEE 802.3: 1000 BASE-T, 100 BASE-TX, 10 BASE-T, PoE, PoE+
2. ANSI/TIA 854: 1000 BASE-TX
3. CDDI, Token Ring, ATM
4. Digital Video
5. Broadband and Baseband Analog Video

- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Refer to drawings for cable manufacturer and part numbers.

2.4 CAT6 TERMINATION HARDWARE

- A. Description: This section covers patch panels, jack modules, modular plugs, faceplates and surface mount boxes.

B. Patch Panels

1. Mounts to standard EIA 19" rack
2. All metal modular patch panels.
3. Stainless steel, painted black
4. Accept shielded and non-shielded jacks.
5. Write-on areas and option adhesive labels for port identification.
6. 24 and 48 port.
7. Flat and angled design.
8. Refer to drawings for manufacturer and part numbers.

C. Jack Modules

1. CAT6/Class E, 8-position
2. Exceeds channel requirements of ANSI/TIA-568.2-D Category 6 and ISO 11801 Class E standards at swept frequencies 1 to 250 MHz
3. Meets ANSI/TIA-1096-A contacts plated with 50 microinches of gold for superior performance
4. Rated for 2500 cycles with IEEE 802.3af / 802.3at and 802.3bt type 3 and type 4. Supports Power over HDBaseT up to 100 watts
5. Operating Temp: -10°C to 65°C (14°F to 149°F)
6. Terminate 4-pair, 22-26 AWG
7. 100 Ohm
8. Several available color options
9. Refer to drawings for manufacturer and part numbers.

D. Modular Plugs

1. CAT6/Class E, 8-position/8 wire
2. Exceeds ANSI/TIA Category 6 and ISO Class E performance requirements when properly terminated to CAT 6
3. Terminate 23-24 AWG (solid or stranded)
4. 100 Ohm
5. Supports PoE, PoE+, and proposed Type 3 and 4 PoE++ applications for up to 100 W

6. Refer to drawings for manufacturer and part numbers.

E. Faceplates - Plastic

1. Available in 1, 2, 3, 4 and 6 port single-gang
2. Optional label windows
3. Accepts variety of CAT6 jacks and AV inserts
4. Refer to drawings for manufacturer and part numbers.

F. Faceplates – Stainless Steel

1. Available in 2, 4 and 6 port single-gang
2. Optional label windows
3. Accepts variety of CAT6 jacks and AV inserts
4. Refer to drawings for manufacturer and part numbers.

G. Surface Mount Boxes

1. Low profile design
2. Variety of port densities
3. Accepts variety of CAT6 jacks and AV inserts
4. Breakouts for use with surface raceway
5. Made of ABS
6. UL 1863 rated
7. Refer to drawings for manufacturer and part numbers.

2.5 CAT6 PATCH CABLES

- A. Description:** Patch cord cable shall be offered in multiple colored UTP cable for design flexibility with a clear strain relief boot on each modular plug.

1. CAT6/Class E
2. Compatible with both T568A and T568B wiring schemes
3. Exceeds all ANSI/TIA-568.2-D and ISO 11801 Class E standards for all frequencies from 1 to 250 MHz
4. Meets ANSI/TIA-1096-A (formerly FCC Part 68); contacts plated with 50 microinches of gold for superior performance
5. UL 1863 approved
6. A variety of lengths shall be available for design flexibility.
7. PoE compliance: Rated for 2500 cycles with IEEE 802.3af / 802.3at and 802.3bt type 3 and type 4
8. Rated to 2500 mating cycles.
9. Field terminated patch cables shall not be allowed in any situation.
10. Refer to drawings for manufacturer and part numbers.

2.6 LABELING

- A. Description:** Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

2. All labels shall be installed on each end of installed cable within 12 inches of termination.
3. Labels shall be:
 - a. Self-laminating vinyl labels
 - b. Permanent acrylic tape that adheres to surfaces that are smooth, rough or powder coated
 - c. Machine-printed labels indicating:
 - 1) Telecommunication Room
 - 2) Patch Panel
 - 3) Patch panel port
4. Hand-Written labels shall **NOT** be allowed in any situation.

2.7 AS-BUILT DRAWINGS

- A. Description: Drawings submitted by contractor upon completion of project reflecting all changes made and documenting all installations.
 1. As-built drawings shall be submitted to TowerPinkster for any/all structured cabling projects.
 2. Each as-built shall indicate locations of all installed cables.
 3. As-built drawing shall only have typed text (No hand-written as-builts).
 4. As-builts shall be submitted in PDF format.
 - a. Any other format requires approval prior to submittal.

2.8 GROUNDING PROVISIONS FOR TWISTED PAIR CABLING

- A. Comply with requirements in Section 27 0526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-D.

2.9 CABLE MANUFACTURER WARRANTY

- A. A cabling manufacturer warranty shall be provided by the installation contractor for all structured cabling projects.
 1. Warranty shall be 25-year standards-based performance warranty that applies to all registered links and/or channels in an installation.
 2. Warranty shall be submitted within 30 days of project completion.

PART 3 - EXECUTION

3.1 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Comply with requirements for raceways and boxes specified in Section 27 0528 "Pathways for Communications Systems."
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.
- D. General Requirements for Cabling:
1. Comply with TIA-568.2-D.
 2. Comply with BICSI's Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 3. Install 110-style IDC termination hardware unless otherwise indicated.
 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
 12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
 13. Provide 5ft service loop at each location (security cameras & wireless access points shall have 15ft)
 14. Bundle CAT6 cables in groups of no more than 24 cables as they route on ladder rack to patch panel in all exposed areas of Telecommunication Rooms.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

3.2 FIRESTOPPING

- A. Comply with requirements in Section 07 8413 "Penetration Firestopping."

- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.3 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-D and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.2-D.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 27 1513

SECTION 27 1700 - TESTING, ID. AND ADMIN OF BALANCED TWISTED PAIR INFRASTRUCTURE

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.
- B. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- C. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge

1.2 SCOPE

- A. This Section includes the minimum requirements for the test certification, identification and administration of horizontal balanced twisted pair cabling.

1.3 SECTION INCLUDES:

- 1. Copper cabling test instruments
- 2. Copper cabling testing
- 3. Identification
 - a. Labels and labeling
- 4. Administration
 - a. Test results documentation
 - b. As-built drawings
- B. Testing shall be carried out in accordance with this document.
- C. Testing shall be performed on each cabling link including MPTL (modular plug terminated link). (100% testing)
- D. All tests shall be documented.

1.4 QUALITY ASSURANCE

- A. All testing procedures and field-test instruments shall comply with applicable requirements of:
 - 1. ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - 2. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
 - 3. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard

4. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
 5. ANSI/TIA-606-C, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.
- B. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
1. Manufacturer of the connectors or cable.
 2. Manufacturer of the test equipment used for the field certification.
 3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida).
- C. The Owner or the Owner's representative shall be invited to witness and/or review field-testing.
1. The Owner or the Owner's representative shall be notified of the start date of the testing phase five (5) business days before testing commences.
 2. The Owner or the Owner's representative will select a random sample of 5% of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the Owner.

1.5 SUBMITTALS

- A. Manufacturers catalog sheets and specifications for the test equipment.
- B. A schedule (list) of all balanced twisted-pair copper links to be tested.
- C. Sample test reports.
- D. Certification results for all installed data cables.

1.6 ACCEPTANCE OF TEST RESULTS

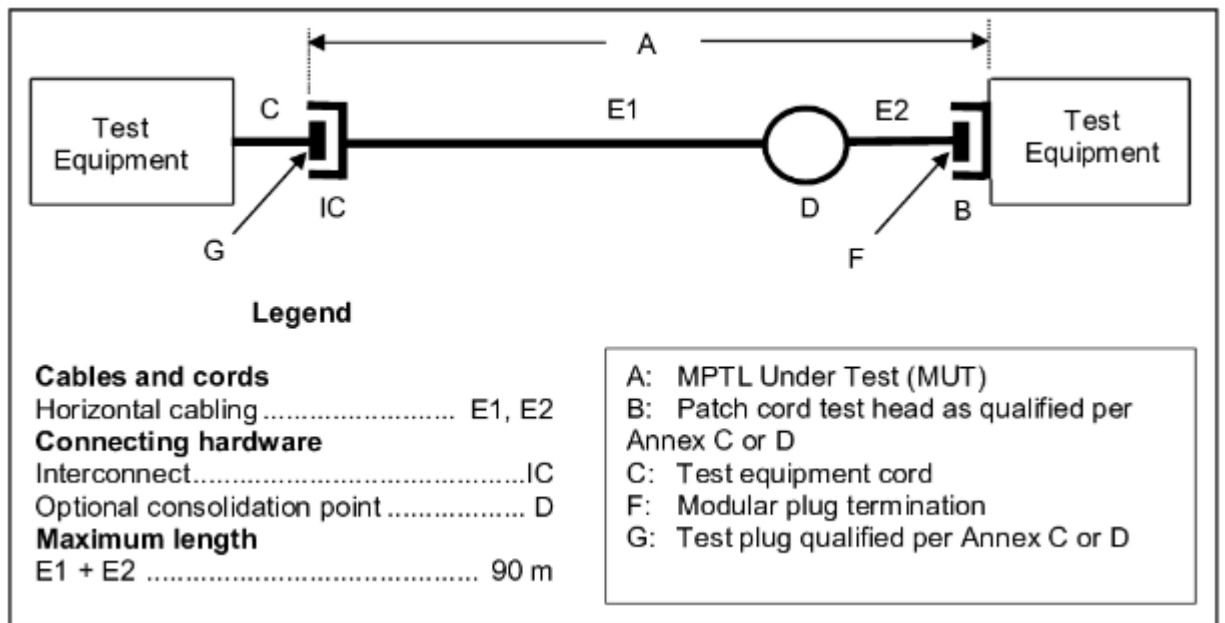
- A. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in tested for:
1. Wire Map
 2. Length
 3. Propagation Delay
 4. Delay Skew
 5. DC Loop Resistance – recorded for information only
 6. DC Resistance Unbalance – recorded for information only
 7. Insertion Loss
 8. NEXT (Near-End Crosstalk)
 9. PS NEXT (Power Sum Near-End Crosstalk)

10. ACR-N (Attenuation to Crosstalk Ratio Near-End) – recorded for information only
11. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for information only
12. ACR-F (Attenuation to Crosstalk Ratio Far-End)
13. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
14. Return Loss
15. TCL (Transverse Conversion Loss) – recorded for information only
16. ELTCTL (Equal Level Transverse Conversion Transfer Loss) – recorded for information only

- B. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described in Part 3. Any Permanent Link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation in accordance with Part 3.
- C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

1.7 MODULAR PLUG TERMINATED LINK (MPTL)

- A. The ANSI/TIA-568.2-D standard requires that horizontal cable be terminated on a telecommunications outlet to provide flexible access to the user. In certain limited cases there may be a need to terminate horizontal cables to a plug that is directly plugged into a device. This will sometimes be done to service a security camera, a radio enabled wireless access device, or another device which is not often moved or rearranged.



- B.

 1. (A) Modular plug terminated link under test (MUT)
 2. (B) Patch cord test head qualifier per Annex C or D in ANSI/TIA-568.2-D
 3. (C) Test equipment patch cord
 4. (D) Optional consolidated point
 5. (E) Horizontal cable
 6. (F) Test plug qualified per Annex C or D in ANSI/TIA-568.2-D

C. Modular plug terminated link transmission requirements

1. Modular plug terminated link shall comply with the permanent link transmission requirements of the ANSI/TIA-568.2-D standard.

PART 2 - PRODUCTS

2.1 BALANCED TWISTED-PAIR CABLE TESTERS

- A. A The field-test instrument shall be within the calibration period recommended by the manufacturer, typically 12 months.
- B. Certification tester
 1. Accuracy
 - a. Level IIIe accuracy in accordance with ANSI/TIA-1152
 - b. Independent verification of accuracy
 2. Permanent Link Adapters
 - a. RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
 - b. Twisted pair Category 5e, 6, 6A, 7 or 7_A cords are not permitted as their performance degrades with use and can cause false Return Loss failures
 3. Results Storage
 - a. Must be capable of storing > 10,000 results for all measurements found in 2.1.B.4 below
 4. Measurement capabilities
 - a. Wire Map
 - b. Length
 - c. Propagation Delay
 - d. Delay Skew
 - e. DC Loop Resistance
 - f. DC Resistance Unbalance
 - g. Insertion Loss
 - h. NEXT (Near-End Crosstalk)
 - i. PS NEXT (Power Sum Near-End Crosstalk)
 - j. ACR-N (Attenuation to Crosstalk Ratio Near-End)
 - k. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 - l. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - m. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - n. Return Loss
 - o. TCL (Transverse Conversion Loss)
 - p. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - q. Time Domain Reflectometer
 - r. Time Domain Xtalk Analyzer
- C. PC Software

1. Windows® based.
2. Must show when 3 dB and 4 dB rules are applied
3. Re-certification capability, where results must have their Cable IDs suffixed with (RC).
4. Built in PDF export – no additional third-party software permitted.
5. Built-in statistical analysis.

2.2 IDENTIFICATION

- A. Labels
 - a. Refer to specification 27 0553 IDENTIFICATION FOR COMMUNICATION SYSTEMS.

2.3 ADMINISTRATION

- A. Administration of the documentation shall include test results of each Permanent Link.
- B. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- C. The test result records saved within the field-test instrument shall be transferred into a Windows® -based database utility that allows for the maintenance, inspection and archiving of these test records.

PART 3 - EXECUTION

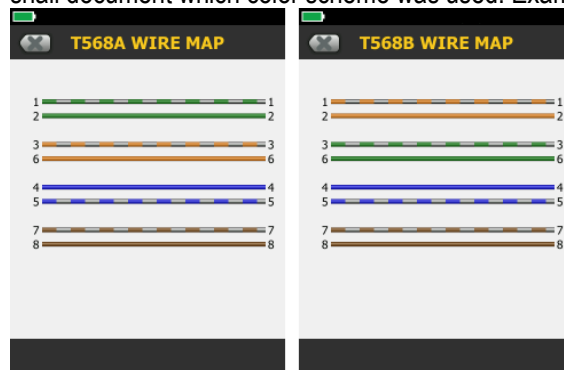
3.1 GENERAL

- A. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

3.2 BALANCED TWISTED PAIR CABLE TESTING

- A. Field-test instruments shall have the latest software and firmware installed.
- B. Permanent Link test results including the individual frequency measurements from the tester shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- C. Testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.
- D. Permanent Link adapters made from twisted pair Category 5e, 6, 6A, 7 or 7_A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- E. The installer shall build a reference link. All components shall be anchored so it is not possible to disturb them. The technician is to conduct a Category 6 Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.
- F. Wire Map Measurement

1. The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For each of the 8 conductors in the cabling, the wire map indicates:
 - a. Continuity to the remote end
 - b. Shorts between any two or more conductors
 - c. Reversed pairs
 - d. Split pairs
 - e. Transposed pairs
 - f. Distance to open on shield
 - g. Any other miss-wiring
2. The correct connectivity of telecommunications outlets/connectors is defined in ANSI/TIA-568-C.2. Two color schemes are permitted. The user shall define which scheme is to be used. The field tester shall document which color scheme was used. Examples are given below:



- 3.
- G. Length Measurement
1. The length of each balanced twisted pair shall be recorded.
 2. Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay shall be reported and used for making the pass or fail determination.
 3. The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in ANSI/TIA-568-C.2 plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 325 ft. (99 m) before a fail is reported.
- H. Propagation Delay measurement
1. Is the time it takes for a signal to reach the end of the link.
 2. The measurement shall be made at 10 MHz per ANSI/TIA-1152.
 3. The propagation delay of each balanced twisted pair shall be recorded.
 4. Is not to exceed 498 ns per ANSI/TIA-568-C.2 Section 6.3.18.
- I. Delay Skew measurement
1. Is the difference in propagation delay @ 10 MHz between the shortest delay and the delays of the other wire pairs.
 2. The delay skew of each balanced twisted pair shall be recorded.
 3. Is not to exceed 44 ns per ANSI/TIA-568-C.2 Section 6.3.19.
- J. DC Resistance

1. Often reported as Resistance, is the loop resistance of both conductors in the pair.
2. Is not specified in ANSI/TIA-1152 but shall be recorded for all four pairs.

K. DC Resistance Unbalance

1. Often reported as Resistance Unbalance, is the difference in resistance of the two wires within the pair.
2. Is not specified in ANSI/TIA-1152 for a Permanent Link but shall be recorded for all four pairs.

L. Insertion Loss

1. Is the loss of signal strength over the cabling (in dB).
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
3. Worst case shall be reported for all four pairs in one direction only.
4. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.7.

M. NEXT (Near-End Crosstalk)

1. Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
3. Shall be measured in both directions. (12 pair to pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.8.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
7. The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.

N. PS NEXT (Power Sum Near-End Crosstalk)

1. Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
3. Shall be measured in both directions. (8 pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.9.

6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
 7. The Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.
- O. ACR-N (Attenuation Crosstalk Ratio Near-End)
1. Is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 3. Shall be calculated in both directions.
 4. Is not specified in ANSI/TIA-1152 but shall be recorded for all 12 possible combinations.
- P. PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End)
1. Is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 3. Shall be calculated in both directions.
 4. Is not specified in ANSI/TIA-1152 but shall be recorded for all 8 possible combinations.
- Q. ACR-F (Attenuation Crosstalk Ratio Far-End)
1. Is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 3. Shall be measured in both directions. (24 pair to pair possible combinations)
 4. Both worst case and worst margins shall be reported.
 5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.11.
 6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
- R. PS ACR-F (Power Sum Attenuation Crosstalk Ratio Far-End)
1. Is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.
 2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
 3. Shall be measured in both directions. (8 pair possible combinations)
 4. Both worst case and worst margins shall be reported.
 5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.13.

6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).

S. Return Loss

1. Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
3. Shall be measured in both directions. (8 pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
6. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.6.
7. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
8. The Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.

T. TCL (Transverse Conversion Loss)

1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
3. Shall be measured in both directions.
4. Is not specified in ANSI/TIA-1152 for a Permanent Link but shall be recorded for all 8 possible combinations.

U. ELTCTL (Equal Level Transverse Conversion Transfer Loss)

1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
2. The frequency resolution shall be:
 - a. 1 – 31.25 MHz: 150 kHz
 - b. 31.25 – 100 MHz: 250 kHz
 - c. 100 – 250 MHz: 500 kHz
3. Shall be measured in both directions.
4. Is not specified in ANSI/TIA-1152 for a Permanent Link but shall be recorded for all 8 possible combinations.

3.3 ADMINISTRATION

A. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
 2. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
 3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD or DVD prior to Owner acceptance of the building. This CD or DVD shall include the software tools required to view, inspect, and print any selection of the test reports.
 4. Circuit IDs reported by the test instrument should match the specified label ID (see **Error! Reference source not found.** of this Section).
 5. The detailed test results documentation data is to be provided in an electronic database for each tested balance twisted-pair and shall contain the following information
 - a. The overall Pass/Fail evaluation of the link-under-test
 - b. The date and time the test results were saved in the memory of the tester
 - c. The identification of the customer site as specified by the end-user
 - d. The name of the test limit selected to execute the stored test results
 - e. The name of the personnel performing the test
 - f. The version of the test software and the version of the test limit database held within the test instrument
 - g. The manufacturer, model and serial number of the field-test instrument
 - h. The adapters used
 - i. The factory calibration date
 - j. Wire Map
 - k. Propagation Delay values, for all four pairs
 - l. Delay Skew values, for all four pairs
 - m. DC Resistance values, for all four pairs
 - n. DC Resistance Unbalance, values for all four pairs
 - o. Insertion Loss, worst case values for all four pairs
 - p. NEXT, worst case margin and worst case values, both directions
 - q. PS NEXT, worst case margin and worst case values, both directions
 - r. ACR-F, worst case margin and worst case values, both directions
 - s. PS ACR-F, worst case margin and worst case values, both directions
 - t. Return Loss, worst case margin and worst case values, both directions
 - u. TCL, worst case values both directions
 - v. ELTCTL, worst case values, both directions.
 - w. Time Domain Crosstalk data if the link is marginal or fails
 - x. Time Domain Reflectometer data if the link is marginal or fails
- B. Record copy and as-built drawings
1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on a CD or DVD. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:

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- a. Field directed changes to pull schedule.
- b. Horizontal cable routing changes.
- c. Associated detail drawings.

END OF SECTION 27 1700

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SECTION 27 5116 - PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preamplifiers.
2. Power amplifiers.
3. Microphones.
4. Control console.
5. Equipment cabinet.
6. Equipment rack.
7. Telephone paging adapters.
8. Tone generator.
9. Loudspeakers.
10. Noise-operated gain controllers.
11. Microphone and headphone outlets.
12. Conductors and cables.
13. Pathways.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Power, signal, and control wiring.
- C. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components 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. Detail fabrication and assembly of supports and seismic restraints for control consoles, equipment cabinets and racks, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain public address system from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. System Functions:
 - 1. Selectively connect any zone to any available signal channel.
 - 2. Selectively control sound from microphone outlets and other inputs.
 - 3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
 - 4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
 - 5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
 - 6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 SYSTEM DESCRIPTION

- A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

- C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with EIA/ECA-310-E.
- D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.5 PREAMPLIFIERS

- A. Preamplifier: Separately mounted.
- B. Preamplifier: Integral to power amplifier.
- C. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
- D. Total Harmonic Distortion: Less than 1 percent.
- E. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
- F. Input Jacks: Minimum of three. One matched for low-impedance microphone; one USB port; and the other matchable to DVD or CD player, or radio tuner signals without external adapters.
- G. Minimum Noise Level: Minus 55 dB below rated output.
- H. Controls: On-off, input levels, and master gain.

2.6 POWER AMPLIFIERS

- A. Mounting: Rack.
- B. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus a 10 percent allowance for future stations.
- C. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
- D. Minimum Signal-to-Noise Ratio: 80 dB, at rated output.
- E. Frequency Response: Within plus or minus 3 dB from 20 to 12,000 Hz.
- F. Output Regulation: Less than 2 dB from full to no load.
- G. Controls: On-off, input levels, and low-cut filter.
- H. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.7 MICROPHONES

A. Paging Microphone:

1. Type: Dynamic, with cardioid polar characteristic.
2. Impedance: 500 ohms.
3. Frequency Response: Uniform, 50 to 15,000 Hz.
4. Sensitivity: Minus 70 dB.
5. Output Level: Minus 58 dB, minimum.
6. Cable: Braided shield cable with Amphenol XLR connectors. Coordinate impedance with microphone impedance.
7. Mounting: Desk stand with integral-locking, press-to-talk switch.

B. <Insert microphone type>.

2.8 CONTROL CONSOLE

A. Cabinet: Modular, desktop; complying with EIA/ECA-310-E.

B. Housing: Steel, 0.0478 inch minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.

C. Panel for Equipment and Controls: Rack mounted.

D. Controls:

1. Switching devices to select signal sources for distribution channels.
2. Program selector switch to select source for each program channel.
3. Switching devices to select zones for paging.
4. All-call selector switch.

E. Indicators: A visual annunciation for each distribution channel to indicate source being used.

F. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.

G. Spare Positions: 20 percent spare zone control and annunciation positions on console.

H. Microphone jack.

2.9 LOUDSPEAKERS

A. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
4. Rated Output Level: 10 W.
5. Minimum Dispersion Angle: 100 degrees.
6. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.

7. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.
8. Flush-Ceiling-Mounted Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.

B. Horn-Type Loudspeakers:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W.
2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
4. Dispersion Angle: 130 by 110 degrees.
5. Mounting: Integral bracket.
6. Units in Damp, Wet, or Outdoor Locations: Listed and labeled for environment in which they are located.
7. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located. Provide any accessories required to maintain listing.

2.10 OUTLETS

- A. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.

2.11 CONDUCTORS AND CABLES

- A. Jacketed, twisted pair and twisted multipair, untinned solid copper.
1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
 2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
 3. Plenum Cable: Listed and labeled for plenum installation.

2.12 PATHWAYS

- A. Conduit and Boxes: Comply with Section 27 0528 "Pathways for Communications Systems." Flexible metal conduit shall not be used.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways and boxes specified in Section 27 0528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements in Section 27 0528 "Pathways for Communications Systems." for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

- A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- C. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- D. Equipment Cabinets and Racks:
 - 1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
 - 2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
 - 3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
- E. Wall-Mounted Outlets: Flush mounted.
- F. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.
- G. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
- H. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- I. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

3.5 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
- C. Install grounding electrodes as specified in Section 27 0526 "Grounding and Bonding for Communications Systems."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Schedule tests with at least seven days' advance notice of test performance.
 - 2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
 - 4. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
 - 5. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
- C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
- D. Public address system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
 - 1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

3.7 ADJUSTING

- A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

END OF SECTION 27 5116

SECTION 28 3100 - FIRE DETECTION AND ALARM

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. Failure to consult these documents shall not relieve the Contractor of the requirements therein.

1.2 SUMMARY

- A. This Section includes fire alarm systems with manual stations, detectors, signal equipment, controls, and devices.
- B. Related Sections include the following:
 - 1. Division 08 Section "Door Hardware".

1.3 DEFINITIONS

- A. FACP: Fire alarm control panel.
- B. LED: Light-emitting diode.
- C. Definitions in NFPA 72 apply to fire alarm terms used in this Section.
- D. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. *General: Provide extension to existing fire alarm system in areas of renovation. Provide all new fire alarm devices and connect to existing system. Provide all required equipment for a complete installation. Retain the services of a factory representative for system design and certification.*

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire alarm system design.
 - b. Fire alarm certified by NICET, minimum Level III.

2. Wiring Diagrams: Detail wiring and differentiate between manufacturer-installed and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified.
 3. Battery: Sizing calculations.
 4. Floor Plans: Indicate final outlet locations and routings of raceway connections.
 5. Alarm Characteristics: Indicate the visual strobe candela and audible sound level requirements to satisfy NFPA 72 and the Authority having jurisdiction.
 6. Device Address List: Coordinate with final system programming.
 7. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
 8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 9. Voice/Alarm Signaling Service: Equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
- C. Operating Instructions: For mounting at the FACP.
- D. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Comply with NFPA 72.
- F. Maintenance Data: For fire alarm systems to include in maintenance manuals specified in Division 01. Comply with NFPA 72.
- G. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals specified in Division 01 Section "Submittal Procedures," make an identical submission to authorities having jurisdiction, (Department of Labor & Economic Growth, Office of Fire Safety, P.O. Box 30254, Lansing, Michigan, 48909). Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.
- H. Certificate of Completion: Comply with NFPA 72.
- I. Inspector's qualifications for the smoke control system.
- J. Smoke control system's test results.
- 1.6 QUALITY ASSURANCE
- A. Installer Qualifications: An experienced installer who is a trained and certified representative of the FACP manufacturer for both installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance.

- C. Source Limitations: Obtain fire alarm system components through one source from a single manufacturer.
- D. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.
- E. Comply with NFPA 72.

1.7 SEQUENCING AND SCHEDULING

- A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment and restore damaged surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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: See Editing Instruction No. 1 in the Evaluations for cautions about naming products and manufacturers.
 - 1. Provide extension to existing EST fire alarm system.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Control of System: By the FACP.
- B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
- C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.
- D. Noninterference: A signal from one device shall not prevent the receipt of signals from other devices.
- E. System Reset: All devices are manually resettable from the FACP after initiating devices are restored to normal.

- F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.
- G. System Alarm Capability during Circuit Fault Conditions: System wiring and circuit arrangement prevent alarm capability reduction when a single ground or open circuit occurs in an initiating device circuit, signal line circuit, or notification-appliance circuit.
- H. Loss of primary power at the FACP initiates a trouble signal at the FACP. The FACP indicates when the fire alarm system is operating on the secondary power supply.
- I. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke or flame or heat detector, or operation of a sprinkler flow device initiates the following:
 - 1. Notification-appliance operation.
 - 2. Identification at the FACP and the remote annunciator of the device originating the alarm.
 - 3. Transmission of an alarm signal to the remote alarm receiving station.
 - 4. Unlocking of electric door locks in designated egress paths.
 - 5. Release of fire and smoke doors held open by magnetic door holders.
 - 6. Shutdown of fans and other air-handling equipment serving area when alarm was initiated.
 - 7. Closing of smoke dampers in air ducts of system serving area where alarm was initiated.
 - 8. Recording of the event in the system memory.
- J. Alarm Silencing, System Reset and Indication: Controlled by switches in the FACP.
 - 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 - 2. Subsequent alarm signals from other devices reactivate notification appliances until silencing switch is operated again.
- K. Water-flow alarm switch operation initiates the following:
 - 1. Notification-appliance operation.
 - 2. Flashing of the device location-indicating light for the device that has operated.
- L. Smoke detection for detectors with alarm verification initiates the following:
 - 1. Audible and visible indication of an "alarm verification" signal at the FACP.
 - 2. Activation of a listed and approved "alarm verification" sequence at the FACP and the detector.
 - 3. Recording of the event in the system memory.
 - 4. General alarm if the alarm is verified.
 - 5. Cancellation of the FACP indication and system reset if the alarm is not verified.
- M. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system initiates the following:
 - 1. A supervisory, audible, and visible "sprinkler trouble" signal indication at the FACP and the annunciator.
 - 2. Flashing of the device location-indicating light for the device that has operated.
 - 3. Recording of the event in the system memory.
 - 4. Transmission of trouble signal to remote central station.

- N. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. Same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity-adjustment schedule changes are recorded in system memory.
- O. Removal of an alarm-initiating device or a notification appliance initiates the following:
 - 1. A "trouble" signal indication at the FACP and the annunciator for the device or zone involved.
 - 2. Recording of the event in the system memory.
 - 3. Transmission of trouble signal to remote alarm receiving station.
- P. Printout of Events: On receipt of the signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble), and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including the same information for device, location, date, and time. Commands initiate the printout of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- Q. FACP Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.

2.3 MANUAL PULL STATIONS

- A. Description: Fabricated of metal or plastic, and finished in red with molded, raised-letter operating instructions of contrasting color.
 - 1. Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm. Break glass/plastic stations are not acceptable.
 - 2. Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
 - 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false alarm operation.
 - 4. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

2.4 SMOKE DETECTORS

- A. General: Include the following features:
 - 1. Operating Voltage: 24-V dc, nominal.
 - 2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
 - 4. Integral Visual-Indicating Light: LED type. Indicates detector has operated.

5. Sensitivity: Can be tested and adjusted in-place after installation.
 6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 7. Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
- B. Photoelectric Smoke Detectors: Include the following features:
1. Sensor: LED or infrared light source with matching silicon-cell receiver.
 2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
 3. Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.
- C. Beam-Type Smoke Detector: Each detector consists of a separate transmitter and receiver with the following features:
1. Adjustable Sensitivity: More than a six-level range, minimum.
 2. Linear Range of Coverage: 330 feet, minimum.
 3. Tamper Switch: Initiates trouble signal at the central FACP when either transmitter or receiver is disturbed.
 4. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status. Any detector trouble, including power loss, is reported to the central FACP as a composite "trouble" signal.
 5. Detectors with prism reflectors are not acceptable.
- D. Duct Smoke Detector: Photoelectric type.
1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
 2. UL 268A listed, operating at 24-V dc, nominal.
 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
 5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
 7. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
 8. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit. Motor shutdown wiring by Temperature Control Supplier.

2.5 OTHER DETECTOR

- A. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate of rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.

1. Mounting: Plug-in base, interchangeable with smoke detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

- A. Description: Equip for mounting as indicated and have screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
- B. Chimes, High-Level Output: Vibrating type, 81 dB minimum rated output.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns produce a sound-pressure level of 90 dB, measured 10 feet from the horn. Beige or Ivory color.
1. Where installed in sleeping areas, provide square wave signal with fundamental frequency of 520 Hz +- 10% per NFPA-72
- D. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens. Beige or Ivory color.
1. Rated Light Output: 15, 30, 75, or 110 candela, as required to satisfy NFPA 72 requirements.
 2. Strobe Leads: Factory connected to screw terminals.
 3. Strobes shall be synchronized.
- E. Voice/Tone Speakers:
1. High-Range Units: Rated 2 to 15 W.
 2. Low-Range Units: Rated 1 to 2 W.
 3. Mounting: Flush, semirecessed, surface, or surface-mounted; bi-directional as indicated.
 4. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
- F. Fire Connection Strobe: Provide all required connections to the strobe/horn associated with the fire fighters hose connection on the exterior of the building. Provide 120V power from nearest panel for devices provided by sprinkler system supplier. Connect to emergency power when available.

2.7 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

- A. Description: LED indicating light near each smoke detector that may not be readily visible, and each sprinkler water-flow switch and valve-tamper switch. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 MAGNETIC DOOR HOLDERS

- A. Provide wiring for magnetic door holders furnished and installed by the door hardware contractor.

2.9 PROGRAMMER/TESTOR

- A. Provide a programmer/testor for any fire alarm system requiring such a device for programming and maintenance of signal initiation devices. Furnish unit complete with carrying case and instructions.

2.10 CENTRAL FACP

- A. Cabinet: Lockable steel enclosure. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.
 - 1. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.
 - 2. Mounting: Flush.
- B. Alarm and Supervisory Systems: Separate and independent in the FACP. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.
- C. Control Modules: Include types and capacities required to perform all functions of fire alarm systems. Provide 20% spare signal capacity for future alarm devices.
- D. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.
- E. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.
- F. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components, including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Display: Liquid-crystal type, 40 (small projects) or 80 (large projects) characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- G. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components, including annunciation, supervision, and control.
 - 1. Display: A minimum of 80 characters; alarm, supervisory, and component status messages; and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

- H. Instructions: Printed or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.11 NOTIFICATION APPLIANCE CIRCUIT (NAC) EXTENDER PANELS

- A. Provide NAC panels as required to support notification appliances.
- B. Provide layout of proposed NAC panel locations prior to installation.

2.12 REMOTE ANNUNCIATOR

- A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, reset, and test.
 - 1. Mounting: Flush cabinet, NEMA 250, Class 1.
- B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.13 FIREFIGHTER'S SMOKE CONTROL STATION

- A. Firefighters Smoke Control Station (FSCS): shall provide full monitoring and manual control capability over all smoke-control/evacuation systems and equipment. The FSCS shall be furnished by the fire alarm system manufacturer. The FSCS shall have the highest priority control over all smoke-control systems and equipment and shall override or bypass other building controls such as Hand-Off-Auto switches and On-Off switches. The FSCS shall depict graphically the physical building arrangement, smoke-control systems and equipment and the areas served by the equipment. Provide all equipment required for complete operation of the smoke control system including but not limited to conduit, wire and interface devices. System shall include the following:
 - 1. Control panel shall be semi-flush mounting with a maximum panel width of 24 inches.
 - 2. Operable controls shall be placed behind a lockable see-through door.
 - 3. Graphic panel with pilot lamps and switches.
 - 4. Provide a pilot lamp test switch to test all lamps on the panel.
 - 5. All lamps shall be LED type.
 - 6. Panel shall be UL Listed as a Firefighters Smoke Control Station under UL864-UUKL for smoke control.
- B. Smoke Control System: Fans within the building shall be shown on the FSCS. A clear indication of the direction of the airflow and the relationship of the components shall be displayed. Status indicators shall be provided for all smoke control equipment, annunciated by fan and zone and by pilot lamp type indicators as follows:
 - 1. Fans, dampers, and other operating equipment in their normal status – White.
 - 2. Fans, dampers, and other operating equipment in their off or closed status – Red.

3. Fans, dampers, and other operating equipment in their on or open status – Green.
 4. Fans, dampers, and other operating equipment in a fault status – Yellow/Amber.
- C. Features: The FSCS shall provide control capability over the complete smoke control system equipment within the building as follows:
1. On-Auto-Off control over each individual piece of operating smoke control equipment that can also be controlled from other sources within the building. This includes stairway pressurization fans; smoke exhaust fans; supply, return and exhaust fans; elevator shaft fans; and other operating equipment used or intended for smoke control purposes.
 2. Open-Auto-Close control over individual dampers related to smoke control and that are also controlled from other sources within the building.
 3. On-Off or Open-Close control over smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the FSCS.
- D. Acceptance Testing: Devices, equipment, components and sequences shall be individually tested. These tests shall consist of determination of function, sequence and capacity of their installed condition. Tests shall include:
1. Detection devices.
 2. Ducts.
 3. Dampers.
 4. Inlet and outlets.
 5. Fans.
 6. Smoke barriers.
 7. Controls.
- E. Special Inspections for Smoke Control: Smoke control systems shall be tested by a third party, special inspector as part of this contract.
1. Qualifications: Special inspection agencies for smoke control shall have experience in fire protection engineering, mechanical, engineering and certification as air balancers.
 2. Reports: A complete report of testing shall be provided by the special inspector. The report shall include identification of all devices by manufacturer, nameplate data, design values, measured values and identification tag or mark.
 3. Report Filing: A copy of the final report shall be filed with the fire code official and a copy shall be maintained in the building.

2.14 EMERGENCY POWER SUPPLY

- A. General: Components include lead acid battery, charger, and an automatic transfer switch.
1. Battery Nominal Life Expectancy: 20 years, minimum.
- B. Battery Capacity: Comply with NFPA 72.
1. Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails.

- C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.
- D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

2.15 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts.

2.16 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled under UL 864 and NFPA 72.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. When supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.
- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- D. Self Test: Conducted automatically every 24 hours with report transmitted to central station.

2.17 GUARDS FOR PHYSICAL PROTECTION

- A. Description: Welded wire mesh of size and shape for the manual stations, smoke detectors, and audio/visual devices located in school gymnasiums, multi-purpose rooms and locker rooms.
 - 1. Factory fabricated and furnished by the manufacturer of the device.
 - 2. Finish: Paint of color to match the protected device.

2.18 WIRE

- A. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
- B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

2.19 GENERATOR CONNECTION

- A. Provide connection to emergency generator system and provide status as indicated in the fire alarm control panel section.

2.20 BREAKER LOCK DEVICE

- A. Provide breaker circuit lockout device on branch circuits feeding any fire alarm equipment including fire alarm panels and NAC panels. Utilize Elock fire alarm circuit lockout kit #ELOCK-FA and a red placard indicating "FIRE ALARM / EMERGENCY CIRCUIT INSIDE".

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Install fire alarm system in accordance with manufacturer's installation drawings and instructions.
- B. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.
 - 1. Connect new equipment to the existing control panel in the existing part of the building.
 - 2. Expand, modify, and supplement the existing control equipment as necessary to extend the existing control functions to the new points. New components shall be capable of merging with the existing configuration without degrading the performance of either system.
- C. Manual Pull Stations: Mount semiflush in recessed back boxes.
- D. Water-Flow Detectors and Valve Supervisory Switches: Connection for each sprinkler valve station required to be supervised.
- E. Ceiling-Mounted Smoke Detectors: Not less than 4 inches from a side wall to the near edge. For exposed solid-joint construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 feet apart in any direction.
- F. Wall-Mounted Smoke Detectors: At least 4 inches, but not more than 12 inches, below the ceiling.
- G. Smoke Detectors near Air Registers: Install no closer than 60 inches.
- H. Duct Smoke Detectors: Comply with manufacturer's written instructions.
 - 1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 2. Install sampling tubes so they extend the full width of the duct.
- I. Audible Alarm-Indicating Devices: Install chimes and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.
- J. Visible Alarm-Indicating Devices: Install adjacent to each alarm chime or alarm horn.

- K. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- L. Horn/strobe at Fire Fighter's Hose Connection: Connect horn/strobe located on the exterior of the building associated with the sprinkler system.
- M. FACP: Surface mount with tops of cabinets not more than 72 inches above the finished floor.
- N. Annunciator: Install with the top of the panel not more than 60 inches above the finished floor.
- O. Provide smoke detectors where required for all FACP and NAC panels.
- P. Provide power to all FACP and NAC panels. Connect to emergency power when available.

3.2 WIRING INSTALLATION

- A. Install wiring according to the following:
 - 1. NECA 1.
 - 2. TIA/EIA 568-A.
- B. Wiring Method:
 - 1. Install wiring in raceways except in accessible ceiling spaces and in gypsum-board partitions where cable wiring method may be used. Route the fire alarm cable in cable tray system when available. Wiring run in ceiling space where there is no tray or conduit, support independently of other systems with dedicated low voltage rings / hooks.
 - 2. Conceal cables and raceways except in unfinished spaces.
 - 3. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 - 4. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.
 - 5. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

- F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signal from other floors.
- G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- H. Provide handle clamps on all circuit breakers feeding fire alarm system components. Handle clamps shall lock the circuit breaker in the "ON" position.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26 Section Identification for Electrical Systems."
- B. Install instructions frame in a location visible from the FACP.
- C. Install circuit breaker lockout kit and placard on panels indicating where emergency fire alarm circuits are fed from.

3.4 GROUNDING

- A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a #8 AWG ground wire from main service ground to the FACP.
- B. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.
- D. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.
- B. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the compliance of the system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items

with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

- C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of witnesses to preliminary tests.
- D. Final Test Notice: Provide a minimum of 10 days' notice in writing when the system is ready for final acceptance testing.
- E. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Test all conductors for short circuits using an insulation-testing device.
 - 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.
 - 4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
 - 5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
 - 6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 - 7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
 - 8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of tests.
- H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.
- I. Provide certification of the fire alarm installation. Submit required documents to the Michigan Department of Labor & Economic Growth, Office of Fire Safety.

3.6 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours' training.
 - 2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.8 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

END OF SECTION 28 3100