CONTRACT DOCUMENTS

AND

SPECIFICATIONS

FOR

PROJECT NO. TMUA-W 16-04
AB JEWELL WATER TREATMENT PLANT
LAB/OFFICE RENOVATION

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

PREPARED BY:
CYNTERGY
810 S. CINCINNATI
TULSA, OK 74119
(918) 877-6000 PH
(918) 877-4000 FAX
LARRY VORBA, AIA

CITY OF Tulsa
A New Kind of *Energy*.

PAUL D. ZACHARY, P.E., DIRECTOR
ENGINEERING SERVICES DEPARTMENT

Account Numbers: 6028-5451101-040522101100
6062-5452101-040522161015

Engineering Services Department
2317 South Jackson Avenue
Tulsa, Oklahoma 74107
(918) 596-9565

VOLUME II – TECHNICAL SPECIFICATIONS

PROJECT MANUAL

Lab/Office Renovation

A.B. Jewell Water Treatment Plant
Tulsa, Oklahoma

Project # TMUA-W 16-04

For Construction
01 September, 2016

For

CITY OF TULSA
TULSA METROPOLITAN UTILITY AUTHORITY

ARCHITECT / ENGINEER

CYNTERGY

Cyntergy, LLC
810 South Cincinnati, Second Floor
Tulsa, Oklahoma 74119
918 877 6000

City of Tulsa
A.B. Jewell Water Treatment Plant
LAB/OFFICE RENOVATION
18707 East 21st Street, Tulsa, OK 74108

Project No. TMUA-W 16-04

City of Tulsa, Oklahoma
Tulsa Metropolitan Utility Authority

Cyntergy Project No. TDPW150006001

DOCUMENT 000007 - SEALS PAGE

ARCHITECT OF RECORD

David F. Phelps, AIA
Cyntergy, LLC
810 South Cincinnati
Second Floor
Tulsa, Oklahoma 74119

STATE OF OKLAHOMA
DAVID F. PHELPS
3504
LICENSED ARCHITECT

Architect of Record — Date: 9.01.2014

MECHANICAL ENGINEER OF RECORD

Jeffery Ferguson, PE
Cyntergy, LLC
810 South Cincinnati
Second Floor
Tulsa, Oklahoma 74119

LICENSED PROFESSIONAL ENGINEER
JEFFERY DON FERGUSON
19755
OKLAHOMA

Mechanical Engineer of Record — Date: 08/31/16

COT-000007

FIRE PROTECTION ENGINEER OF RECORD

James Spradling, PE
Cyntergy, LLC
810 South Cincinnati
Second Floor
Tulsa, Oklahoma 74119

REGISTERED PROFESSIONAL ENGINEER
JAMES ROY SPRADLING
18683
OKLAHOMA

8-31-16

Fire Protection Engineer of Record Date

SECTION 000110 – TABLE OF CONTENTS

Division	Section Title
DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS	
000001	Cover Sheet
000101	Project Title Page
000107	Seals Page
000110	Table of Contents
DIVISION 01 - GENERAL REQUIREMENTS	
011000	Summary
012100	Allowances
012200	Unit Prices
012300	Alternates
012500	Substitution Procedures
013100	Project Management and Coordination
013300	Submittal Procedures
014000	Quality Requirements
015000	Temporary Facilities and Controls
016000	Product Requirements
017300	Execution
017700	Closeout Procedures
DIVISION 02 – EXISTING CONDITIONS	
024119	Selective Demolition
DIVISION 05 - METALS	
054000	Cold Formed Metal Framing
DIVISION 06 - WOOD AND PLASTICS	
061053	Miscellaneous Rough Carpentry
062023	Interior Finish Carpentry
DIVISION 07 - THERMAL AND MOISTURE PROTECTION	
072100	Thermal Insulation
076200	Sheet Metal Flashing and Trim
078413	Penetration Firestopping
078443	Joint Firestopping
079200	Joint Sealants
DIVISION 08 – OPENINGS	
081113	Hollow Metal Doors and Frames
081416	Flush Wood Doors
083113	Access Doors and Frames
087100	Door Hardware
088000	Glazing
DIVISION 09 – PAINTING AND COATING	
092216	Non-Structural Metal Framing
092900	Gypsum Board
095113	Acoustical Panel Ceilings
096513	Resilient Base and Accessories
096519	Resilient Tile Flooring
096813	Tile Carpeting
099000	Painting and Coating

DIVISION 12 – FURNISHINGS
123216.10 Industrial Laminate Clad Casework

DIVISION 21 – FIRE SUPPRESSION
211313 Wet-Pipe Sprinkler Systems
212200 Clean-Agent Fire-Extinguishing Systems

DIVISION 22 – PLUMBING
220517 Sleeves and Sleeve Seals for Plumbing Piping In Progress
220518 Escutcheons for Plumbing Piping
220529 Hangers and Supports for Plumbing Piping and Equipment
220533 Heat Tracing for Plumbing Piping
220553 Identification for Plumbing Piping and Equipment
220719 Plumbing Piping Insulation
221116 Domestic Water Piping
221316 Sanitary Waste and Vent Piping
221319 Sanitary Waste Piping Specialties
224500 Emergency Plumbing Fixtures
226113 Compressed-Air Piping for Laboratory Facilities
226213 Vacuum Piping for Laboratory Facilities
226313 Gas Piping for Laboratory Facilities
226600 Chemical-Waste Systems for Laboratory Facilities
226700 Processed Water Systems for Laboratory Facilities

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING
230513 Common Motor Requirements for HVAC Equipment
230517 Sleeves and Sleeve Seals for HVAC Piping
230523.12 Ball Valves for HVAC Piping
230529 Hangers and Supports for HVAC Piping and Equipment
230548.13 Vibration Controls for HVAC
230553 Identification for HVAC Piping and Equipment
230593 Testing, Adjusting, and Balancing for HVAC
230719 HVAC Piping Insulation
230800 Commissioning of HVAC
230900 Instrumentation and Control for HVAC
231123 Facility Natural-Gas Piping
232213 Steam and Condensate Heating Piping
232216 Steam and Condensate Piping Specialties
233113 Metal Ducts
233300 Air Duct Accessories
233423 HVAC Power Ventilators
237433 Dedicated Outdoor-Air Units
238123.13 Computer-Room Air-Conditioners, Ceiling-Mounted Units
238126 Split-System Air-Conditioners
238216.14 Electric-Resistance Air Coils
238413 Humidifiers

DIVISION 28 –ELECTRONIC SAFETY AND SECURITY
283112 Fire-Alarm System

END OF TABLE OF CONTENTS 000110

EXHIBIT A – CONTRACTOR MANAGEMENT PROGRAM

City of Tulsa
AB Jewell WTP Lab/Office
Contractor Site Management Program

Prior to beginning work at the City of Tulsa AB Jewell WTP Lab/Office, all contractors shall appoint an Onsite Safety Representative. The Onsite Safety Representative will receive an orientation briefing from the plant superintendent regarding contractor requirements and expectations. This briefing will include the following:

- Visitor and Security Policy
- Contact and emergency information
- Completion of Contractor's designated onsite safety representative form
- Protection of drinking water quality and discharge streams
- Tools and equipment
- Site tobacco policy
- Site parking and driving requirements
- Site housekeeping requirements
- Discrimination policy
- Drug and alcohol policy
- Emergency Action Plan
- Notification of accidents, incidents, and near misses
- Required Personal Protective Equipment (PPE)
- Required permits for performing the work and means of obtaining permits, i.e. hot work permit, confined space, etc.
- Fall protection
- Lockout-tagout
- Permit-required confined spaces
- Use of electrical equipment
- General Contractor responsibilities

1.0 VISITOR AND SECURITY POLICY		☐ Completed
Provide a copy and review Visitor and Security Policy.		
2.0 CONTACT AND EMERGENCY INFORMATION		☐ Completed
Internal Resources	**Office**	**Mobile**
Stefanie Hunter, Plant Superintendent	918-596-8020	918-277-5152
Steve Goodman, Operations Supervisor	918-596-8021	918-284-9188
John Curry, Maintenance Supervisor	918-596-8053	918-284-9189
External Resources		
Police/ Fire Department/HAZMAT	911	
City of Tulsa Security	918-576-5502	
CHEMTREC	800-424-9300	
3.0 DESIGNATION OF CONTRACTOR'S ONSITE SAFETY REPRESENTATIVE		☐ Completed
Complete ONSITE SAFETY REPRESENTATIVE form.		
4.0 TOOLS AND EQUIPMENT		☐ Completed
All work performed will be completed with Contractor's tools and equipment. City of Tulsa tools and equipment will not be used.		
5.0 SITE TOBACCO POLICY		☐ Completed

Tobacco materials shall be defined as cigarettes, e-cigarettes, cigars, pipes, smokeless tobacco, and other tobacco-related substances. The use of tobacco materials shall be prohibited at all times within City-owned or leased facilities except for the areas approved by the Mayor and appropriately marked as "Smoking Area".

6.0 PARKING AND DRIVING REQUIREMENTS	☐ Completed

- Parking and driving of vehicles should only be done on paved areas within the plant.
- Speed Limit within the plant is 15 mph.
- Seatbelts are required by all vehicle occupants when in motion inside plant grounds.
- Yield to pedestrians approaching internal roadways.
- Come to a complete stop at all STOP signs.

7.0 SITE HOUSEKEEPING REQUIREMENTS	☐ Completed

It is the responsibility of the Contractor to maintain a clean and orderly work area to minimize safety hazards. It has been shown that poor housekeeping leads to slips, trips, and falls on construction sites. The Contractor shall ensure that all work areas are clean at the end of each work day. All equipment and/or material stored outside shall be secured to prevent hazards created by adverse weather conditions.

Clear access shall always be maintained to electrical panels, fire extinguishers, safety showers/eyewash stations, and fire hydrants.

It should be understood that the function of this facility is to produce drinking water consumed by the public. As such, it is the responsibility of the Contractor to properly contain and dispose of any trash, chemicals, wastewater runoff, and any other waste or byproduct produced from their work. Some worksites may be in close proximity to treatment processes which must not be contaminated, directly or indirectly, as a result of the contractors work. If an incidence of contamination occurs, or is suspected, it must be immediately reported to the plant superintendent.

8.0 DISCRIMINATION POLICY	☐ Completed

The City of Tulsa is committed to, and shall provide, a work environment which is free from all forms of discrimination and harassment. Unprofessional behavior that creates a hostile work environment for individuals with regard to gender, age, race, religion, physical disabilities, or sexual orientation will not be tolerated. Violators will be removed from the site.

9.0 DRUG AND ALCOHOL POLICY	☐ Completed

Employees and visitors shall not report to work at the site under the influence of any substance that may affect their ability to safely perform their work or that may in any way jeopardize the health and safety of others. If there is reason to believe that someone is under the influence of drugs or alcohol, that person will be removed from the worksite. If a controlled or illegal substance is suspected, the proper authorities will be contacted. Illegal substances shall not be brought to the site.	
10.0 SITE-SPECIFIC EMERGENCY ACTION PLAN (EAP)	☐ Completed
A copy of the site-specific EAP will be distributed and reviewed.	
11.0 NOTIFICATION OF CONTRACTOR ACCIDENTS, INCIDENTS AND NEAR MISSES	☐ Completed
All incidents and accidents must be reported immediately to the plant superintendent. All near misses must be reported to the plant superintendent no later than the end of the day on which the event occurs.	
12.0 REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE)	☐ Completed
Contractors are responsible for providing their employees with proper PPE and must train them in the proper inspection, maintenance, and safe use of that equipment. Contractors are responsible for conducting job assessments to determine the proper PPE necessary for each job. At a minimum, contractor employees are expected to wear hard hats, steel-toed work boots, and safety glasses at all times. Additionally, fall protection, respirators, gloves, face shields, and hearing protection may be required, depending on hazards present.	
13.0 REQUIRED PERMITS FOR CERTAIN ACTIVITIES AND MEANS FOR OBTAINING THOSE PERMITS	☐ Completed

___ Hot Work Permit

Anything that generates heat, flame, or spark, or any electrical hot work requires a hot work permit. An appropriate fire extinguisher and a dedicated, trained fire watch person who understands the hazards associated with hot work must be present at all times. Coordinate with the site maintenance supervisor to obtain a hot work permit.

_____ Confined Space Entry Permit

All contractors conducting confined space entries must coordinate with the plant maintenance supervisor prior to entering any confined space. Contractors must provide proof that their employees have been adequately trained in their duties and hazards associated with their work. Contractors must provide their own calibrated air monitors and rescue equipment. Coordinate with the site maintenance supervisor to obtain a confined space entry permit.

_____ Lockout/Tagout Permit

Contractors must coordinate their Lockout/Tagout procedures with the site maintenance supervisor. Once affected circuits, piping, dissipated hazardous energy, switches, valves and/or other processes have been locked and tagged out by the City of Tulsa AB Jewell WTP Lab/Office personnel, the Contractor shall place a lock on the City's to ensure against accidental start-up.

14.0 FALL PROTECTION	☐ Completed

Contractors performing work 6' or more above a lower level shall use fall protection in accordance with applicable OSHA regulations and City of Tulsa Policies and Procedures.

15.0 LOCKOUT-TAGOUT	☐ Completed

Distribute and review the City of Tulsa Safety and Health Manual (S&HM) Section 308, "Lockout/Tagout". All work requiring Lockout/Tagout shall be in accordance with applicable OSHA regulations and City of Tulsa Policies and Procedures.

16.0 PERMIT-REQUIRED CONFINED SPACES	☐ Completed

Review designated site-specific permit-required confined space locations. All permit-required confined space entries shall be performed in accordance with applicable OSHA regulations and City of Tulsa Policies and Procedures.

17.0 USE OF ELECTRICAL EQUIPMENT AND GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)	☐ Completed

All electrical equipment must be connected to a GFCI. Tools shall be regularly inspected for defects such as cuts, exposed insulation, missing ground pins, etc. Tools with damaged cords or plugs shall be removed from service immediately.

Contractors must provide their own source of power for all tools and equipment. Site electrical outlets should not be used for powering tools and equipment.

18.0 CONTRACTOR RESPONSIBILITIES	☐ Completed

- Comply with current federal safety and environmental regulations and all applicable state and local laws, codes, rules, regulations, and ordinances governing the work.
- Ensure Contractor provides all necessary tools and equipment, including personal protective equipment, required for safe completion of required tasks.
- Train employees and ensure they understand expectations of this Program. A copy of the CONTRACTOR TRAINING LOG must be completed and submitted to the plant superintendent prior to any employee beginning work at the facility. The training log must be updated if Contractor adds any employees throughout the duration of work.
- Provide documentation of employee training, as requested.
- Perform inspection of work activities and areas for compliance with requirements of this Program.
- Inform plant superintendent of any subcontractors to be used as part of the work. The Onsite Safety Representative must review this program with all subcontractor employees prior to any site work. Training should be documented on the SUBCONTRACTOR TRAINING LOG and submitted to the plant superintendent each time employees are added. Contractor is responsible for ensuring subcontractor employees comply with requirements of this program.
- Ensure that no Contractor activities endanger other personnel working at the site.
- Participate in all evacuation drills.
- Understand that failure to comply with requirements of this Program, including failure to correct unsafe practices and conditions, are sufficient grounds for the plant superintendent to stop all work until deficiencies have been corrected.
- To reserve a meeting room for construction progress meetings, contact the administrative assistant to the plant superintendent at least one week prior to the scheduled date to ensure availability.

Date Completed: _____

Contractor Name: _____

Site Safety Representative: _____

Phone Number: _____

Email Address: _____

Plant Superintendent: _____

CONTRACTOR ONSITE SAFETY REPRESENTATIVE

Name of Contractor: _____

Project: _____

The following person has been designated as the Contractor Onsite Safety Representative for the above-referenced contract. He/she is capable of identifying hazards on the jobsite, including working conditions that are unsanitary, hazardous, or dangerous to employees. In addition, this employee is the contact person between the City of Tulsa AB Jewell WTP Lab/Office and _____ **(insert name of Contractor)**, in the event that the City of Tulsa drinking water treatment personnel observe any unsafe condition, practice, etc.

Contractor Onsite Safety Representative:

Name (printed): _____

Title: _____

Signature: _____

Date: _____

CONTRACTOR TRAINING LOG

Instructor: _____ Date: _____

I have trained the employees listed below on the City of Tulsa Drinking AB Jewell WTP Lab/Office Contractor Site Management Program.

Instructor Signature: _____

Employee Name	Employee Signature	Contractor	Date

SUBCONTRACTOR TRAINING LOG

Instructor: _____ Date: _____

I have trained the employees listed below on the City of Tulsa Drinking AB Jewell WTP Lab/Office Contractor Site Management Program.

Instructor Signature: _____

Employee Name	Employee Signature	Contractor	Date

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Project information.
2. Work covered by Contract Documents.
3. Access to site.
4. Coordination with occupants.
5. Work restrictions.
6. Specification and drawing conventions.
7. References

B. Related Documents and Requirements:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. Section 01 21 00 – Allowances, for procedures governing the use of Owner Allowances during construction.
3. Section 01 23 00 – Alternates, for complete description of Base Bid Work and each Alternate and procedures for incorporation into the Work.
4. Section 01 50 00 - Temporary Facilities and Controls, for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification:
1. Project Name: AB Jewell WTP Lab/Office Improvements; Project Number: TWUA-W 16-04.
   a. Contact: Hua Jiang.
2. Project Location: 18707 East 21st Street, Tulsa, OK 74134

B. Owner: City of Tulsa.
1. Owner's Inspector: To be determined.

C. Architect: Cyntergy.
1. Project Manager/Engineer of Record: Larry L. Vorba, PE, PMP.
2. All references to time in these specifications is in calendar days.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work consists of mobilization, demobilization, and miscellaneous, for the demolition of the existing library and a portion of the training space on second floor and renovation of the space to three new offices plus a SCADA room; the demolition of two existing offices on third floor and renovation of the space to two new lab areas; and the replacement of the existing HVAC roof mounted equipment serving the third floor with new roof mounted equipment serving the existing and new lab spaces on third floor as well as the new SCADA room on second floor.

The work includes reconfiguring lighting, fire suppression, power and related HVAC distribution systems as noted on the documents to serve the new areas.

B. Type of Contract:
   1. Project will be constructed under a single prime contract, City of Tulsa standard contract.

1.4 ACCESS TO SITE

A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

B. Use of Site: Limit use of Project site to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
   1. Driveways, Walkways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
      a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
      b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weather-tight condition throughout construction period. Repair damage caused by construction operations.

1.5 COORDINATION WITH OCCUPANTS

A. Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
   1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
   2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.6 PHASED CONSTRUCTION

A. Contractor shall work with Owner to develop a Phasing Plan to minimize interference with Owner's operations.

B. Before commencing Work of each phase, submit an updated copy of Contractor's construction schedule showing the sequence, commencement and completion dates, and move-out and -in dates of Owner's personnel for all phases of the Work.

1.7 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.
   1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00AM to 7:00PM, Monday through Friday, excluding legal holidays, unless otherwise indicated or approved by the Engineer. Re: General Conditions.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
   1. Notify Owner not less than two days in advance of proposed utility interruptions.
   2. Obtain Owner's written permission before proceeding with utility interruptions.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
   1. Notify Owner not less than two days in advance of proposed disruptive operations.
   2. Obtain Owner's written permission before proceeding with disruptive operations.

E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor-air intakes.

F. Security: During construction period, Contractor shall install barricades as required to restrict construction area access to the public. Contractor to coordinate security requirements with the City of Tulsa Representative.

G. Employee Background Checks: All Contractor employees on the site shall have OSBI background checks and photo ID's at all times while on the premises. Any cost in relation to background checks is to be paid for by contractor.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
   1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
   2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
   1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.

2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.9 REFERENCES

A. Industry Standards:
   1. 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.
   2. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   3. Copies of Standards: Each entity engaged in construction on the Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
      a. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 012100 - ALLOWANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.
   1. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor.

B. Types of allowances include the following:
   1. Owner Contingency Allowances: Unit-cost allowances.

C. Related Documents and Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
   2. Section 01 22 00 "Unit Prices" for procedures for using unit prices.

1.2 SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances as directed by the Architect or Owner.

1.3 OWNER CONTINGENCY ALLOWANCES

A. An Owner Contingency allowance of Ten Thousand Dollars ($10,000.00) has been provided in the Contract for additional work not identified in the Contract and for use according to Owner's instructions.

B. The allowance shall be used only at the discretion of the City of Tulsa. Any allowance balance remaining at the completion of the project will be credited back to the City of Tulsa on the final Application for Payment submitted by the Contractor.

C. Use the contingency allowance only as directed by Architect and Owner for Owner's purposes that indicate quantities and amounts to be charged to the allowance.

D. Contractor's overhead, profit, and related costs for materials, products and equipment as directed by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum or Alternate Work Sums. These costs include delivery, labor, installation, insurance, equipment rental, and similar costs.

E. Directives authorizing use of funds from the Owner's contingency allowance will include Contractor's related costs and reasonable overhead and profit margins as originally bid on the Bid Form.

F. The Contractor shall provide, to the City of Tulsa Representative, a written request for the use of the allowance, with a schedule of values, and all associated backup information, including any time extensions required to perform the work.

G. Contractor shall proceed with work included in the allowance only after receiving a written order, from the City of Tulsa Representative, authorizing such work. Proceeding with work in the allowance without a written order from the City of Tulsa Representative will be at the Contractor's cost.

1.4 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
   1. Include installation costs in purchase amount as part of the allowance.
   2. Submit substantiation of a change in scope of work, if any, claimed in unit-cost allowances.
   3. Owner reserves the right to establish the quantity of work-in-place by quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents.
   1. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

END OF SECTION 012100

SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for Unit Prices.

B. Related Documents and Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
   2. Contract – Proposal: for estimated quantities and unit prices.

1.2 DEFINITIONS

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

B. Determinations for Unit Price Work: Owner will determine the actual quantities and classifications of Unit Price Work performed by Contractor based on materials receipts. Owner will review with Contractor the preliminary determinations on such matters before rendering a decision thereon (by recommendation of an Application for Payment or otherwise). Owner's written decision thereon will be final and binding (except as modified to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of any Claims.

C. Unit Price Work:
   1. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
   2. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Owner's Field Engineering personnel.
   3. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
   4. Owner or Contractor may make a Claim for an adjustment in the Contract Price if:
      a. The quantity of any item of Unit Price performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
      b. There is no corresponding adjustment with respect to any other item of Work; and

c. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

1.3 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Owner will confirm Contractor's measurement of work-in-place that involves use of established unit prices with Owner's Field Engineering personnel.

D. List of Unit Prices: The schedule of unit prices is included in the Contract - Proposal. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012200

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes descriptions of Base Bid Work, Alternates, plus administrative and procedural requirements for alternates.

B. Related Documents and Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 BASE BID WORK

A. The Work consists of mobilization, demobilization, and miscellaneous, for the demolition of the existing library and a portion of the training space on second floor and renovation of the space to three new offices plus a SCADA room; the demolition of two existing offices on third floor and renovation of the space to two new lab areas; and the replacement of the existing HVAC roof mounted equipment serving the third floor with new roof mounted equipment serving the existing and new lab spaces on third floor as well as the new SCADA room on second floor. The work includes reconfiguring lighting, fire suppression, power and related HVAC distribution systems as noted on the documents to serve the new areas.

3.2 SCHEDULE OF ALTERNATES

A. Alternate No. One: Clean Agent fire Extinguishing System.

END OF SECTION 012300

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Documents and Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
   2. Section 012100 "Allowances" for products selected under an allowance.
   3. Section 012300 "Alternates" for products selected under an alternate.
   4. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions during Bidding: Changes proposed by Bidders that are being offered for consideration during the Bidding process.
   2. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   3. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
   4. The Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with Owner's change procedures.
   5. Warranty: The Contractor warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective.

1.3 SUBMITTALS

A. Substitution Requests: Submit six hard copies and one electronic PDF format document of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use facsimile of form provided at the end of this Section.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable.
      a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.

b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES or other qualified code organization.
j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action during Bidding: Architect may request additional information or documentation for evaluation of the substitution request. Architect's approval of a substitute during bidding does not relieve Contractor of the responsibility to submit required shop drawings and to comply with all other requirements of the Contract Documents.
   a. Form of Acceptance during Bidding: Addendum.

4. Architect's Action during Construction: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor through City Field Engineering of acceptance or rejection of proposed substitution within 15 calendar days of receipt of request.
   a. Form of Acceptance during Construction: Allowance Authorization.
   b. Form of Acceptance during Construction, when cost of proposed substitution exceeds available funds in Owner's Allowance: Change Order.
   c. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.5 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS DURING BIDDING

A. Substitutions during Bidding: No substitution will be considered prior to receipt of Bids unless written request for approval has been received by the Architect at least ten days prior to the date for receipt of Bids. Such requests shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitution including drawings, performance and test data, and other information necessary for a thorough evaluation. A statement setting forth changes in other materials, equipment or other portions of the Work, including changes in the work of other contracts that incorporation of the proposed substitution would require, shall be included. The burden of proof of the merit of the proposed substitution is upon the proposer. The Architect's decision of approval or disapproval of a proposed substitution shall be final.
   1. If the Architect approves a proposed substitution prior to receipt of Bids, such approval will be set forth in an Addendum. Bidders shall not rely upon approvals made in any other manner.
   2. Substitution Request Form: Each request for substitution shall be submitted on the Substitution Request Form provided at the end of this Section.

2.2 SUBSTITUTIONS DURING CONSTRUCTION

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 calendar days prior to time required for preparation and review of related submittals.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      b. Requested substitution provides sustainable design characteristics that specified product provided.
      c. Substitution request is fully documented and properly submitted.
      d. Requested substitution will not adversely affect Contractor's construction schedule.
      e. Requested substitution has received necessary approvals of authorities having jurisdiction.

f. Requested substitution is compatible with other portions of the Work.
g. Requested substitution has been coordinated with other portions of the Work.
h. Requested substitution provides specified warranty.
i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2. Substitution Request Form: Each request for substitution shall be submitted on the Substitution Request Form provided at the end of this Section.

B. Substitutions for Convenience: Architect will consider requests for substitution if received within 30 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution 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.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Requested substitution provides sustainable design characteristics that specified product provided.
e. Substitution request is fully documented and properly submitted.
f. Requested substitution will not adversely affect Contractor's construction schedule.
g. Requested substitution has received necessary approvals of authorities having jurisdiction.
h. Requested substitution is compatible with other portions of the Work.
i. Requested substitution has been coordinated with other portions of the Work.
j. Requested substitution provides specified warranty.
k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2. Substitution Request Form: Each request for substitution shall be submitted on the Substitution Request Form provided at the end of this Section.

C. Owner's Approval: Under no circumstances will a substitution be allowed without the Owner's written approval.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SUBSTITUTION REQUEST FORM

Project: AB Jewell WTP Lab Improvements
To: _____
_____
_____
Re: _____

Substitution Request Number: _____
Date: _____
From: _____
COT Project Number: TWUA-W 16-04
Contract for: _____

Specification Section: _____
Specification Title: _____

Description: _____
Page: _____ Article/Paragraph: _____

Proposed Substitution: _____
Manufacturer: _____
Trade Name: _____

Address: _____
_____

Installer/Subcontractor: _____
Address: _____
History: [ ] New Product [ ] 1-4 years old [ ] 5-10 years old [ ] More than 10 years old

Differences between proposed substitution and specified products: _____
_____
_____
_____
_____
_____

[ ] Point-by-Point comparative data attached – REQUIRED BY A/E

Reason for not providing specified item: _____
_____
_____

Similar Installation:
Project: _____
Address: _____
_____

Address: _____
Owner: _____
Date Installed: _____

Proposed substitution affects other parts of the Work: [ ] No [ ] Yes; explain: _____
_____

Savings to Owner (City of Tulsa) for accepting substitution: _____$ _____
Proposed substitution changes Contract Time: [ ] No [ ] Yes [Add] [Deduct] _____days.

Supporting data attached: [ ] Drawings [ ] Product Data [ ] Samples [ ] Samples [ ] Tests
[ ] Reports [ ] Other _____

Attached data includes product description, specifications, drawings, photographs, and performance and test data adequate for evaluation of the request; applicable portions of the data are clearly identified. Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

COT-012500

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.

Submitted by: _____

Firm: _____

Address: _____

_____

Telephone: _____ email: _____

Signed by: _____ Date: _____

A/E's REVIEW AND ACTION

[ ] Substitution Approved: Make submittals in accordance with Specification Section 012500 Substitution Procedures.

[ ] Substitutions Approved as Noted: Make submittals in accordance with Specification Section 012500 Substitution Procedures.

[ ] Substitution Rejected: Use specified materials.

[ ] Substitution Request received too late: Use specified materials.

Signed by: _____ Date: _____

Supporting Data Attached: [ ] Drawings [ ] Product Data [ ] Samples [ ] Samples [ ] Tests
[ ] Reports [ ] Other _____

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General coordination procedures.
   2. Requests for Information (RFIs).
   3. Project meetings.

B. Related Documents and Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
   2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.2 DEFINITIONS

A. RFI: Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

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

1.4 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Pre-installation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.5 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716 or Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Software attachments shall be electronic files in Adobe Acrobat PDF format.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven calendar days for Architect's response for each RFI.
   1. The following Contractor-generated RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for approval of Contractor's means and methods.
      d. Requests for coordination information already indicated in the Contract Documents.
      e. Requests for adjustments in the Contract Time or the Contract Sum.
      f. Requests for interpretation of Architect's actions on submittals.
      g. Incomplete RFIs or inaccurately prepared RFIs.
   2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
   3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to General Conditions."
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect.
   4. RFI number including RFIs that were returned without action or withdrawn.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's response was received.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.
   1. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.6 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
   1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
   2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
   3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

B. Preconstruction Conference: Owner, City of Tulsa Field Engineering, will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner after execution of the Agreement.

1. Conduct the conference to review responsibilities and personnel assignments.
2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect progress, including the following:
   a. Tentative construction schedule.
   b. Phasing: Second floor offices must be completed prior to beginning of demolition of third floor.
   c. Critical work sequencing and long-lead items.
   d. Designation of key personnel and their duties.
   e. Lines of communications.
   f. Procedures for processing field decisions and Change Orders.
   g. Procedures for RFIs.
   h. Procedures for testing and inspecting.
   i. Procedures for processing Applications for Payment.
   j. Distribution of the Contract Documents.
   k. Submittal procedures.
   l. Preparation of record documents.
   m. Use of the premises and existing building.
   n. Work restrictions.
   o. Working hours.
   p. Owner's occupancy requirements.
   q. Responsibility for temporary facilities and controls.
   r. Procedures for moisture and mold control.
   s. Procedures for disruptions and shutdowns.
   t. Construction waste management and recycling.
   u. Parking availability.
   v. Office, work, and storage areas.
   w. Equipment deliveries and priorities.
   x. First aid.
   y. Security.
   z. Progress cleaning.
4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Pre-Installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.
   1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Owner-Field Engineering and Architect of scheduled meeting dates.
   2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
      a. Contract Documents.
      b. Options.
      c. Related RFIs.
      d. Related Change Orders.
      e. Purchases.
      f. Deliveries.
      g. Submittals.
      h. Review of mockups.

i. Possible conflicts.
j. Compatibility requirements.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Owner-Field Engineering will schedule and conduct a project closeout conference, at a time convenient to Owner and Architect prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Owner-Field Engineering, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
a. Preparation of record documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Submittal of written warranties.
d. Requirements for preparing operations and maintenance data.
e. Requirements for delivery of material samples, attic stock, and spare parts.
f. Requirements for demonstration and training.
g. Preparation of Contractor's punch list.
h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
i. Submittal procedures.
j. Owner's partial occupancy requirements.
k. Installation of Owner's furniture, fixtures, and equipment.
l. Responsibility for removing temporary facilities and controls.
4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

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

F. Coordination Meetings: Conduct Project coordination meetings at regular intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.
   1. Attendees: In addition to representatives of Owner-Field Engineering, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.

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

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.7 SAFETY AND ORIENTATION BRIEFING

A. All Contractors and Sub-Contractors are required to attend a mandatory Safety and Orientation Briefing prior to mobilization and construction activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for the administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, Scheduled of Values, Project Schedule, Manufacturer's Certificates and other submittals.

B. Related Documents and Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
   2. General Conditions: Payment Procedures for submitting Applications for Payment and the schedule of values.

1.2 DEFINITIONS

A. Submittals: Written and graphic information and physical samples that require Architect's and COT-Field Engineering responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

C. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.3 SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and COT-Field Engineering and additional time for handling and reviewing submittals required by those corrections.
   1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
   2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 14 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
   3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:
   a. Scheduled date for first submittal.
   b. Specification Section number and title.
   c. Submittal category: Action; informational.
   d. Name of subcontractor.
   e. Description of the Work covered.
   f. Scheduled date for Architect's and COT-Field Engineering final release or approval.
   g. Scheduled date of fabrication.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will **not** be provided by Architect for Contractor's use in preparing submittals.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
   3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
   4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. Architect and COT-Field Engineering reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's and COT-Field Engineering receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
   1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect and COT-Field Engineering will advise Contractor when a submittal being processed must be delayed for coordination.
   2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
   3. Resubmittal Review: Allow 15 days for review of each resubmittal.

D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
   1. Indicate name of firm or entity that prepared each submittal on label or title block.
   2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect and COT-Field Engineering.

3. Include the following information for processing and recording action taken:
   a. Project name.
   b. Date.
   c. Name of Architect.
   d. Name of Construction Manager.
   e. Name of Contractor.
   f. Name of subcontractor.
   g. Name of supplier.
   h. Name of manufacturer.
   i. Submittal number or other unique identifier, including revision identifier.
      1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06 10 00.01).
   j. Number and title of appropriate Specification Section.
   k. Drawing number and detail references, as appropriate.
   l. Location(s) where product is to be installed, as appropriate.
   m. Other necessary identification.
4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect and COT-Field Engineering observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
   a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect and COT-Field Engineering.
5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect and COT-Field Engineering will discard submittals received from sources other than Contractor.
   a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
      1) Project name.
      2) Date.
      3) Destination (To:).
      4) Source (From:).
      5) Name and address of Architect.
      6) Name of Construction Manager.
      7) Name of Contractor.
      8) Name of firm or entity that prepared submittal.
      9) Names of subcontractor, manufacturer, and supplier.
      10) Category and type of submittal.
      11) Submittal purpose and description.
      12) Specification Section number and title.
      13) Specification paragraph number or drawing designation and generic name for each of multiple items.
      14) Drawing number and detail references, as appropriate.
      15) Indication of full or partial submittal.
      16) Transmittal number, numbered consecutively.
      17) Submittal and transmittal distribution record.
      18) Remarks.
      19) Signature of transmitter.

E. Electronic Submittals: Submit one electronic copy in addition to hard copy documents. Electronic documents shall be in PDF format. Hard copy documents submitted to the Contractor by suppliers and subcontractors shall be scanned by the Contractor to PDF prior to electronic submittal.

F. Options: Identify options requiring selection by Architect.

G. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect and COT-Field Engineering on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
   1. Note date and content of previous submittal.
   2. Note date and content of revision in label or title block and clearly indicate extent of revision.
   3. Resubmit submittals until they are marked with approval notation from Architect's and COT-Field Engineering's action stamp.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's and COT-Field Engineering's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
   1. Submittals: Submit six paper copies of each submittal unless otherwise indicated. Architect, through COT-Field Engineering will return three copies.
   2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
      a. Provide a notarized statement on original paper copy certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's catalog cuts.
      b. Manufacturer's product specifications.
      c. Standard color charts.
      d. Statement of compliance with specified referenced standards.
      e. Testing by recognized testing agency.

f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:
   a. Wiring diagrams showing factory-installed wiring.
   b. Printed performance curves.
   c. Operational range diagrams.
   d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format: Six paper copies of Product Data unless otherwise indicated. Architect, through COT-Field Engineering will return three copies.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Identification of products.
   b. Schedules.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.
   f. Relationship and attachment to adjoining construction clearly indicated.
   g. Seal and signature of professional engineer if specified.
2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 22 by 34 inches.
3. Submit Shop Drawings in the following format:
   a. Six opaque (bond) copies of each submittal. Architect and COT-Field Engineering, will return three copies.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Provide submittals for all chemical-resistant products used in laboratory.
2. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
3. Identification: Attach label on unexposed side of Samples that includes the following:
   a. Generic description of Sample.
   b. Product name and name of manufacturer.
   c. Sample source.
   d. Number and title of applicable Specification Section.
   e. Specification paragraph number and generic name of each item.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or

containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit six sets of Samples. Architect and COT – Field Engineering will retain three Sample sets; remainder will be returned.

1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.
5. Submit product schedule in the following format:

a. Six paper copies of product schedule or list unless otherwise indicated. Architect, through COT-Field Engineering, will return three copies.

F. Contractor's Construction Schedule: Comply with requirements specified in agreement.

G. Application for Payment and Schedule of Values: Comply with General Conditions.

H. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."

I. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

J. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

K. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

L. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

M. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

N. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

O. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

P. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

Q. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
   1. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect and COT-Field Engineering.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S and COT-FIELD ENGINEERING ACTION

A. Action Submittals: Architect and COT-Field Engineering will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect and COT-Field Engineering will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

B. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect and COT-Field Engineering.

C. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

D. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 013300

SECTION 014000 -QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner or authorities having jurisdiction are not limited by provisions of this Section.
   4. Specific test and inspection requirements are not specified in this Section.

C. Related Documents and Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

C. Testing Agency: An entity engaged to perform specific tests. Testing laboratory shall mean the same as testing agency.

D. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
   1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

E. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.3 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding. Insert an article on special compliance with a governing code only if necessary. Such provisions typically belong in the Supplementary Conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Entity responsible for performing tests and inspections.
   3. Description of test and inspection.
   4. Identification of applicable standards.
   5. Identification of test and inspection methods.
   6. Number of tests and inspections required.
   7. Time schedule or time span for tests and inspections.
   8. Requirements for obtaining samples.
   9. Unique characteristics of each quality-control service.

1.5 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
   1. Project quality-control manager may also serve as Project superintendent.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing: Refer to Electrical and Mechanical Drawings for specific testing requirement.

E. Contractor-performed tests including subcontractor-performed tests. Include required tests and Contractor-elected tests.

1.6 REPORTS AND DOCUMENTS

A. Test Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, and telephone number of testing agency.
   4. Dates and locations of tests.
   5. Names of individuals making tests.
   6. Description of the Work and test method.
   7. Identification of product and Specification Section.
   8. Complete test data.
   9. Test results and an interpretation of test results.
   10. Record of temperature and weather conditions at time of testing.
   11. Comments or professional opinion on whether tested Work complies with the Contract Document requirements.
   12. Name and signature of laboratory inspector.
   13. Recommendations on retesting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
   1. Name, address, and telephone number of technical representative making report.
   2. Statement on condition of substrates and their acceptability for installation of product.
   3. Statement that products at Project site comply with requirements.
   4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
   5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   6. Statement whether conditions, products, and installation will affect warranty.
   7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
   1. Name, address, and telephone number of factory-authorized service representative making report.
   2. Statement that equipment complies with requirements.
   3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
   4. Statement whether conditions, products, and installation will affect warranty.
   5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
   1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
   1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
   2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
   1. Contractor responsibilities include the following:
      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
      d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
      e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
      f. When testing is complete, remove test specimens, assemblies, and mockups, and laboratory mockups; do not reuse products on Project.

K. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, through Construction Manager, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.8 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
   2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.

3. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
   1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
   2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
      a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
   4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Architect, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Architect, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   6. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Delivery of samples to testing agencies.
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
   1. Distribution: Distribute schedule to Owner, Architect, Construction Manager, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.9 SPECIAL TESTS

A. Special Tests: Contractor shall engage a qualified testing agency to conduct fastener pull tests required by authorities having jurisdiction as the responsibility of Contractor.
   1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
   2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
   3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
   4. Submitting a final report of special tests and inspections at Substantial Completion which includes a list of unresolved deficiencies.
   5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted.
   2. Description of the Work tested or inspected.
   3. Date test or inspection results were transmitted to Architect.
   4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Electricity and lighting; telephone service; water; sanitary facilities; construction aids; temporary roofing; enclosures; barriers; cleaning during construction; project identification; field offices and sheds.

1.2 RELATED REQUIREMENTS

A. Section 011000 - Summary: Summary of Work sequence, Contractor's use of premises.
B. Section 017700 – Closeout Procedures: Cleaning - final cleaning.

1.3 ELECTRICITY AND LIGHTING

A. Provide electrical service, including branch wiring and distribution boxes located to allow service and lighting by means of construction-type power cords connected to spare circuits on the Owner's power panel or to convenience receptacles nearby. The Owner will pay cost of energy used through existing services.
B. Provide lighting for construction operations.
C. Provide connections to grounding system as required by codes.
D. Contractor's Option: Provide electrical power by means of portable generators.

1.4 TELEPHONE SERVICE

A. Telephone service to field office shall be provided by Contractor by means of mobile phone.

1.5 WATER

A. Provide connection to domestic water at hose bib; extend branch piping with outlets located so that water is available by use of hoses for construction and fire fighting. Confirm with Owner the use of a construction meter to monitor water usage for payment by Contractor.

1.6 SANITARY FACILITIES

A. The Contractor shall provide separate toilet facilities for laborers. The Owner will not provide toilet facilities. Maintain facilities for laborers. Construction labor shall not use toilets in the Owner's building.

1.7 FIRE FIGHTING EQUIPMENT

A. Provide minimum (1) 20lb pressurized water and (1) 10lb ABC Dry Chemical fire extinguisher on the roof and (1) 10 lb ABC Dry Chemical fire extinguisher at the asphalt kettle at all times of work activity.

1.8 FLAME PRODUCING DEVICES

A. No flame producing devices shall be allowed without protecting nearby combustible materials.

1.9 CONSTRUCTION AIDS

A. Provide and operate drainage and pumping equipment as necessary to drain excavations created on the site by work of this contract.

1.10 ENCLOSURES

A. Provide temporary weather-tight enclosures of openings in exterior surfaces to provide acceptable working conditions and to prevent entry of un-authorized persons.

1.11 BARRIERS

A. Provide as required to prevent public entry to construction areas to provide for Owner's use of site and building, and to protect existing facilities and landscaping and adjacent properties from damage from construction operations.

1.12 CLEANING DURING CONSTRUCTION

A. Control accumulation of waste material and rubbish; daily dispose of off-site.
B. Clean up debris at the end of each day's work.

1.13 PROJECT IDENTIFICATION

A. Allow no advertising signs to be displayed except on Vehicles.

1.14 REMOVAL

A. Remove temporary materials, equipment, services, and construction prior to Substantial Completion inspection.
B. Clean and repair damage caused by installation or use of temporary facilities.

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Material and equipment incorporated into the Work:
   1. Conform to applicable specifications and standards.
   2. Comply with size, make, type and quality specified, or as specifically approved in writing by the Owner's Representative.
   3. Manufactured and Fabricated Products:
      a. Design, fabricate and assemble in accordance with the best engineering and shop practices.
      b. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.
      c. Two or more items of the same kind shall be identical and by the same manufacturer.
      d. Products shall be suitable for service conditions.
      e. Equipment capacities, sizes, and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.
   4. Do not use material or equipment for any purpose other than that for which it is designed or is specified.

1.2 RELATED REQUIREMENTS

A. Section 01 25 00 – Substitution Procedures.
B. Section 01 33 00 – Submittal Procedures; Shop Drawings, Product Data and Samples.
C. Section 01 77 00 – Closeout Procedures.

1.3 REUSE OF EXISTING MATERIAL

A. Except as specifically indicated or specified, materials and equipment removed from the existing structure shall not be used in the completed Work.

1.4 MANUFACTURER'S INSTRUCTIONS

A. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including two copies to the Architect.
B. Handle, install, connect, clean, condition, and adjust products in strict accordance with such instructions and in conformity with specified requirements.
   1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Owner's Representative for further instructions.
   2. Do not proceed with work without clear instructions.
C. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

1.5 TRANSPORTATION AND HANDLING

A. Arrange deliveries of products in accordance with construction schedules, coordinate to avoid conflict with work and conditions at the site.
   1. Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
   2. Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals, and that products are properly protected and undamaged.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

1.6 STORAGE AND PROTECTION

A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible.
   1. Store products subject to damage by the elements in weather tight enclosures or trailers.
   2. Maintain temperature and humidity within the ranges required by manufacturer's instructions.

B. Exterior Storage:
   1. Store fabricated products above ground or on the roof, on blocking or skids to prevent soiling or staining. Cover products which are subject to deterioration with impervious sheet coverings, provide adequate ventilation to avoid condensation.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration.

D. Protection After Installation:
   1. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. Remove when no longer needed.

1.7 PRODUCT OPTIONS

A. Products List:
   1. For products specified only by reference standard, select any product meeting that standard.
   2. For products specified by naming several products or manufacturers, or listed in an Addendum as approved prior to bidding, select one of the products or manufacturers named, which complies with the specifications.
   3. For products specified by naming one or more products or manufacturers with "Allowed Substitutions", Contractor shall submit a request as for substitutions not less than 10 days prior to the bid date for any product or manufacturer not specifically named.
   4. For products specified by naming only one product and manufacturer, and substitutions are not allowed, there is no option.

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
   1. Construction layout.
   2. Field engineering and surveying.
   3. Installation of the Work.
   4. Cutting and patching.
   5. Coordination of Owner-installed products.
   6. Progress cleaning.
   7. Starting and adjusting.
   8. Protection of installed construction.

B. Related Documents and Requirements:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
   2. Section 011000 "Summary" for limits on use of Project site.
   3. Section 013300 "Submittal Procedures" for submitting surveys.
   4. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
   5. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

1.2 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.3 INFORMATIONAL SUBMITTALS

A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
   1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
   2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
   3. Products: List products to be used for patching and firms or entities that will perform patching Work.
   4. Dates: Indicate when cutting and patching will be performed.
   5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
   6. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.4 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
   1. Provide protection of existing laboratory equipment from dust and debris generated by construction work.
   2. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
   3. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety. Operational elements include the following:
      a. Primary operational systems and equipment.
      b. Fire separation assemblies.
      c. Air or smoke barriers.
      d. Fire-suppression systems.
      e. Mechanical systems piping and ducts.
      f. Control systems.
      g. Communication systems.
      h. Fire-detection and -alarm systems.
      i. Conveying systems.
      j. Electrical wiring systems.
      k. Operating systems of special construction.
   4. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
      a. Water, moisture, or vapor barriers.
      b. Membranes and flashings.
      c. Exterior curtain-wall construction.
      d. Sprayed fire-resistive material.
      e. Equipment supports.
      f. Piping, ductwork, vessels, and equipment.
      g. Noise- and vibration-control elements and systems.
   5. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Safety Precautions: The laboratory contains flammable liquids and volatile chemicals. Flames and welding are strictly prohibited.

C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
   1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
   2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
   3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
   1. Description of the Work.
   2. List of detrimental conditions, including substrates.
   3. List of unacceptable installation tolerances.
   4. Recommended corrections.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings.

B. Establish limits on use of Project site.

C. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.

D. Inform installers of lines and levels to which they must comply.

E. Check the location, level and plumb, of every major element as the Work progresses.

F. Notify Architect when deviations from required lines and levels exceed allowable tolerances.

G. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

3.4 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
   4. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
   5. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
   6. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
   7. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
   8. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
   9. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
   10. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
   11. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   12. Allow for building movement, including thermal expansion and contraction.
   13. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
      a. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
      b. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.5 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
3. Temporary Support: Provide temporary support of work to be cut.
4. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

B. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."

C. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

D. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
      a. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
      b. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
      c. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
      d. Proceed with patching after construction operations requiring cutting are complete.
      e. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
      f. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
      g. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
      h. Clean piping, conduit, and similar features before applying paint or other finishing materials.
      i. Restore damaged pipe covering to its original condition.
      j. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
      k. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
      l. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
      m. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas.
   1. Enforce requirements strictly. Dispose of materials lawfully.
   2. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   3. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
   4. Use containers intended for holding waste materials of type to be stored.
   5. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Closeout procedures.
B. Final cleaning.
C. Project Record Documents.
D. Operation and maintenance data.
E. Warranties and bonds.

1.2 RELATED REQUIREMENTS

A. Section 011000 - Summary.
B. Section 015000 – Temporary Facilities and Controls.
C. Section 017300 – Execution; cutting and patching.

1.3 CLOSEOUT PROCEDURES

A. Comply with procedures stated in General Conditions of the Contract for issuance of Certificate of Substantial Completion.
B. When Contractor considers Work has reached final completion, submit written certification that the Contract Documents have been reviewed, Work has been inspected, and that the Work is complete in accordance with the Contract Documents and ready for Owner Representative's inspection.
C. Owner will occupy the Project, under provisions stated in Certificate of Substantial Completion.
D. At the end of all Work of this contract and in addition to submittals required by the conditions of the Contract, provide submittals required by governing authorities, and submit a final statement of accounting giving total adjusted Contract Sum, previous payments, and sum remaining due. Submit Contractor's, Sub-Contractor's and Material Supplier's release of Liens.

1.4 FINAL CLEANING

A. Execute prior to final inspection.
B. Clean surfaces exposed to view if soiled by construction; remove temporary labels, stains and foreign substances and polish transparent and glossy surfaces. Clean equipment and fixtures to a sanitary condition.
C. Clean site; sweep and vacuum paved areas and rake clean other areas.
D. Remove waste and surplus materials, rubbish, and construction facilities from the Project and from the site.
E. Remove protective coverings from sensitive laboratory equipment at completion of final cleaning. Do not disturb or move equipment except as indicated by Owner.

1.5 PROJECT RECORD DOCUMENTS

A. Store documents separate from those used for construction.

B. Keep documents current; do not permanently conceal work until required information has been recorded.

C. At Contract closeout, submit documents with transmittal letter containing date, Project title, Contractor's name and address, list of documents, and signature of Contractor.

D. Make repairs or replacement to existing surfaces damaged by Work of this contract.

E. Owner's operating and maintenance manuals for replaced mechanical equipment.

1.6 WARRANTIES AND BONDS

A. Provide duplicate, notarized copies. Execute Contractor's submittals and assemble documents executed by subcontractors, suppliers, and manufacturers.

B. Submit material prior to final application for payment. For items of Work delayed materially beyond Date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

END OF SECTION 017700

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items to be reused or recycled.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to CITY ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 PREINSTALLATION MEETINGS

A. Pre-demolition Conference: Conduct conference at project site as part of the pre-construction conference.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Pre-demolition Photographs or Video: Submit before Work begins.

C. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.5 CLOSEOUT SUBMITTALS

A. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

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 CITY's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by CITY as far as practical.

C. Notify Engineer 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 CITY before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by CITY 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.

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 so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

D. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
   1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. CITY will arrange to shut off indicated services/systems when requested by Contractor.
   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 to be removed.
      a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
      b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
      c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
      d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
      e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
      f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
      g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
   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. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   5. Dispose of demolished items and materials promptly.

B. 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 CITY.
   4. Transport items to CITY's storage area designated by CITY.
   5. Protect items from damage during transport and storage.

C. 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.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition, cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off of CITY's property and legally dispose of them.

3.6 CLEANING

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

END OF SECTION 024119

SECTION 054000 – COLD FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Load-bearing wall framing.
2. Floor joist framing.
3. Ceiling joist framing.

B. Related Requirements:
1. Section 055000 "Metal Fabrications" for masonry shelf angles and connections.
2. Section 092216 "Non-Structural Metal Framing" for interior non-load-bearing metal-stud framing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products.
1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Miscellaneous structural clips and accessories.

C. Research/Evaluation Reports: For cold formed metal framing.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code - Steel."
   2. AWS D1.3, "Structural Welding Code - Sheet Steel."

A. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, 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 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
   1. Allied Studco.
   2. AllSteel Products, Inc.
   3. California Expanded Metal Products Company.
   4. Clark Steel Framing.
   5. Consolidated Fabricators Corp.; Building Products Division.
   6. Craco Metals Manufacturing, LLC.
   7. Custom Stud, Inc.
   8. Dale/Incor.
   9. Design Shapes in Steel.
   10. Dietrich Metal Framing; a Worthington Industries Company.
   11. Formetal Co. Inc. (The).
   12. Innovative Steel Systems.
   13. MarinoWare; a division of Ware Industries.
   14. Quail Run Building Materials, Inc.
   15. SCAFCO Corporation.
   16. Southeastern Stud & Components, Inc.
   17. Steel Construction Systems.
   18. Steeler, Inc.
   19. Super Stud Building Products, Inc.
   20. United Metal Products, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

A. Steel Sheet: ASTM A 1003, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
   1. Grade: As required by structural performance.
   2. Coating: G60 (Z180).

2.4 LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: As indicated.
   2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
   1. Minimum Base-Metal Thickness: Matching steel studs.
   2. Flange Width: 1-1/4 inches.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: As indicated.
   2. Flange Width: 1-5/8 inches.

2.5 FLOOR JOIST FRAMING

A. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: As indicated.
   2. Flange Width: 1-5/8 inches, minimum.

B. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: Matching steel joists.
   2. Flange Width: 1-1/4 inches, minimum.

2.6 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
   1. Supplementary framing.
   2. Bracing, bridging, and solid blocking.
   3. Web stiffeners.
   4. Anchor clips.
   5. End clips.
   6. Foundation clips.
   7. Gusset plates.
   8. Stud kickers and knee braces.
   9. Joist hangers and end closures.
   10. Hole reinforcing plates.
   11. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153, Class C or mechanically deposition according to ASTM B 695, Class 50.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

E. 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.

F. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

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

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

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.

2.9 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate framing assemblies using jigs or templates.
   2. Cut framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
   4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
   1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
   1. Cut framing members by sawing or shearing; do not torch cut.
   2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
      a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
      b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads 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.

G. Install insulation, specified in Section 072100 "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.

H. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

I. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
   1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 LOAD-BEARING WALL INSTALLATION

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
   1. Anchor Spacing: As indicated.

B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
   1. Stud Spacing: As indicated.

C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls to supporting structure as indicated.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
   1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
   2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
   1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically 48 inches. Fasten at each stud intersection.
   1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
   2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
   3. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacing indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
   1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
   2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated.

C. Space joists not more than 2 inches from abutting walls, and as follows:
   1. Joist Spacing: As indicated.

D. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.

E. 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.
   1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated. Fasten bridging at each joist intersection as follows:
   1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
   2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.6 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel 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 steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wood blocking, cants, and nailers.
   2. Wood furring.
   3. Wood sleepers.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. American Lumber Standards Committee (ALSC):
   1. Softwood Lumber Standards.

C. ASTM International (ASTM):
   1. ASTM A 123/A - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A 653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   4. ASTM A 307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   5. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
   6. ASTM E 1333 - Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber.

D. American Wood Protection Association (AWPA):
   1. AWPA U1 - User Specification for Treated Wood.
   2. AWPA M4 - Care of Preservative Treated Wood Products.

E. Department of Commerce (National Institute of Standards and Technology) – Product Standard (DOC):
   1. DOC PS 2 - Performance Standard for Wood Based Structural Use Panels.

F. International Code Council (ICC):
   1. Table 2304.9.1 – Fastener Requirements.

G. International Code Council Evaluation Services (ICC-ES):
   1. ESR-1539 – Power-Driven Staples and Nails.

H. National Lumber Grades Authority (NLGA):
   1. Grading Rules.

I. Northeastern Lumber Manufacturers Association (NELMA):
   1. Grading Rules.

J. Southern Pine Inspection Bureau (SPIB):
   1. Grading Rules.

K. West Coast Lumber Inspection Bureau (WCLIB):
   1. Grading Rules.

L. Western Wood Products Association (WWPA):
   1. Western Lumber Grading Rules.

1.3 QUALITY ASSURANCE

A. Lumber Grading Agency: Lumber to be grade stamped by an agency certified by the Board of Review of the American Lumber Standards Committee (ALSC).

B. Regulatory Requirements: Conform to applicable codes for fire retardant treatment of wood surfaces for flame/smoke ratings.

PART 2 - PRODUCTS

2.1 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC3b for exterior construction not in contact with the ground.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.2 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. Cants.
   4. Furring.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber 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. 2 grade; SPIB.
   2. Eastern softwoods, No. 2 Common grade; NELMA.

3. Northern species, No. 2 Common grade; NLGA.
4. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Where carpentry is exposed to weather, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153.

B. Power-Driven Fasteners: ICC-ES ESR-1539.

2.4 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Self-adhesive butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spun-bonded polyolefin to produce an overall thickness of not less than 0.025 inch.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit.

B. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

C. Do not splice structural members between supports unless otherwise indicated.

D. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

E. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. ICC-ES ESR-1539 for power-driven fasteners.
   2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

END OF SECTION 061053

SECTION 062023 - INTERIOR FINISH CARPENTRY

1.1 SUMMARY

A. Section Includes:
   1. Interior trim.
   2. Ceiling Paneling.
   3. Shelving and clothes rods.
   4. Plastic Laminate.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

B. Samples: For each type of paneling.

1.3 DELIVERY, STORAGE AND HANDLING

A. Transport, handle, store, and protect products in compliance with the requirements of Section 016000.

B. Inspect materials delivered and reject those not qualifying with requirements, those damaged in transit, or those that appear otherwise unsatisfactory.

C. Schedule delivery of items to installation areas that are in proper condition to receive them. Place items neatly and systematically to avoid damage, store in clean, dry, enclosed, and secure storage area.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install architectural woodwork 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following acceptable manufacturers:
   1. Wilsonart, Temple, TX, (800) 433-3222.

B. Substitutions not allowed.

2.2 MATERIALS, GENERAL

A. Lumber: DOC PS 20.
   1. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
      a. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.

B. Softwood Plywood: DOC PS 1.

C. Hardboard: AHA A135.4.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent respectively.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
   1. For exposed lumber and plywood indicated to receive a stained or natural finish, mark back of each piece.

C. Application: Where indicated.

2.4 INTERIOR TRIM

A. Softwood Lumber Trim:
   1. Species and Grade: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; Finish or 1 Common (Colonial); NeLMA, NLGA, or WWPA.
   2. Species and Grade: Douglas fir-larch or Douglas fir south, Prime or D finish; NLGA, WCLIB, or WWPA.
   3. Species and Grade: Southern pine, C & Btr finish; SPIB.
   4. Species and Grade: Western red cedar, Grade B; NLGA, WCLIB, or WWPA.
   5. Maximum Moisture Content: 15 percent.

B. Hardwood Lumber Trim:
   1. Species and Grade: Red oak; Clear; NHLA.
   2. Maximum Moisture Content: 9 percent.

C. Softwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA WM 4, N-grade wood moldings. Made to patterns included in WMMPA WM 12.
   1. Species: Western red cedar.
   2. Maximum Moisture Content: 15 percent.

D. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA HWM 2, N-grade wood moldings made to patterns included in WMMPA HWM 1.
   1. Species: Red oak.
   2. Maximum Moisture Content: 9 percent.

E. Moldings for Opaque Finish (Painted Finish): Made to patterns included in WMMPA WM 12.
   1. Softwood Moldings: WMMPA WM 4, P grade.
      a. Species: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine.
      b. Maximum Moisture Content: 15 percent.
   2. Hardwood Moldings: WMMPA HWM 2, P-grade.
      a. Species: Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar.
      b. Maximum Moisture Content: 9 percent.
   3. Optional Material: Primed MDF.

F. Molding Patterns:
   1. Base Pattern: WM 623, 9/16-by-3-1/4-inch ogee base.
   2. Shoe-Mold Pattern: WM 129, 7/16-by-11/16-inch quarter-round shoe mold.
   3. Casing Pattern: WM 327, 11/16-by-2-1/4-inch clamshell casing.
   4. Stop Pattern: WM 946, 3/8-by-1-3/8-inch ogee stop.
   5. Chair-Rail Pattern: WM 297, 11/16-by-3-inch chair rail.

2.5 CEILING PANELING

A. Board Paneling (Sales Ceilings):
   1. Species and Grade: Ponderosa Pine or Douglas Fir-larch; C Select (Choice); NeLMA, NLGA, or WWPA.
   2. Ceiling surface to be: "Knotty" pine, tongue and groove with "V" edges. 3/4 thick by 6" wide. Provide random lengths from 8 to 16 feet. Flame spread of not less than 200.
   3. Maximum Moisture Content: 15 percent.

2.6 SHELVING AND CLOTHES RODS

A. Shelving: Made from one of the following materials, 3/4 inch thick.
   1. Softwood Boards: Eastern white, Idaho white, lodgepole, ponderosa, radiata, or sugar pine; C Select (Choice); NeLMA, NLGA, or WWPA; kiln dried.
   2. Softwood Boards: Douglas fir-larch, Douglas fir south, or hem-fir; Superior or C & Btr finish; NLGA, WCLIB, or WWPA; or southern pine, B & B finish; SPIB; kiln dried.

B. Shelf Cleats: 3/4-by-3-1/2-inch boards, as specified above for shelving.

C. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.

D. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.

E. Clothes Rods: 1-1/2-inch- diameter, clear, kiln-dried Douglas fir or southern pine.

2.7 LAMINATE MATERIALS

A. High Pressure Laminate (HPL): NEMA LD3: Color, pattern, and finish as indicated in this Section. Exposed Horizontal and Vertical Surfaces: GP-50. Postformed Surfaces: PF-42. Provide HPL products as manufactured by the following as specified in the Color/Pattern Schedule below:
   1. Provide HPL products with Chemsurf finish where indicated.

2.8 COLOR/PATTERN SCHEDULE

A. Provide laminate specified below as applicable as shown on Drawings.
   1. PL-1: Casual Linen 4944-60, by Wilsonart.
      a. Finish: Chemsurf, matte finish.

B. Substitutions not allowed.

2.9 PLASTIC LAMINATE ACCESSORIES

A. Adhesives: Low VOC adhesive, as recommended by laminate manufacturer and suitable for shop or field application.
   1. Provide one of the following products or equivalent as recommended by laminate manufacturer.
      a. Wilsonart 3000 Adhesive Series. (Do not use for metallic surfaces)
      b. Sta'-Put SP80.
      c. Titebond Neoprene Plus.

B. Adhesives for Laboratory and Prep Area: Provide Zero VOC adhesive.

C. Fasteners: Unless otherwise recommended by manufacturer, use size and type to suit application. Use galvanized or stainless for high humidity locations. Use plain finish at other locations.

2.10 MISCELLANEOUS MATERIALS

A. Low-Emitting Materials: Adhesives shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
   1. Wood glue shall have a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Paneling Adhesive: Comply with paneling manufacturer's written recommendations for adhesives.
   1. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.2 INSTALLATION, GENERAL

A. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
   1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
   2. Countersink fasteners, fill surface flush, and sand unless otherwise indicated.
   3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
   4. Install stairs with no more than 3/16-inch variation between adjacent treads and risers and with no more than 3/8-inch variation between largest and smallest treads and risers within each flight.

3.3 STANDING AND RUNNING TRIM INSTALLATION

A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Cope or Miter at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints.

3.4 PANELING INSTALLATION

A. Board Paneling: Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
   1. Install in full lengths without end joints.
   2. Stagger end joints in random pattern to uniformly distribute joints on each wall.
   3. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards. Install with uniform tight joints between boards.
   4. Fasten paneling by face nailing, setting nails, and filling over nail heads.
   5. Fasten paneling with trim screws, set below face and filled.
   6. Fasten paneling by blind nailing through tongues.

3.5 SHELVING AND CLOTHES ROD INSTALLATION

A. Cut shelf cleats at ends of shelves about 1/2 inch less than width of shelves and sand exposed ends smooth.

B. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches on center.

C. Install shelf brackets according to manufacturer's written instructions, spaced not more than 32 inches on center. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.

D. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.

3.6 PLASTIC LAMINATE CASEWORK

A. Install woodwork plumb, level, and straight without distortion; use concealed shims. Scribe and cut woodwork to fit adjoining work. Anchor woodwork items to nailers or blocking or directly to substrate using concealed fasteners.

B. Casework: Provide well-fitting and smooth operating doors and drawers.

C. Countertops: Anchor plastic laminate countertops securely to base units.

D. Install laminate with directional pattern or grain oriented vertically.

END OF SECTION 062023

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Batt Insulation.

1.2 DELIVERY, STORAGE AND HANDLING

A. Transport, handle, store, and protect products in compliance with the requirements of Section 016000 and manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide products from one of the following manufacturers as specified in the Materials paragraph below:
   1. CertainTeed Corporation, Valley Forge, PA (800) 523-7844.
   2. Dow Building Solutions, Midland, MI (866) 583-2583.
   3. Guardian Fiberglass Inc., Albion, MI (800) 748-0035.
   4. Johns Manville Insulations, Denver, CO (877) 766-3295.
   5. Owens-Corning, Toledo, OH (800) 438-7465.

B. Substitutions not allowed.

2.2 REGULATORY REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods specified. Identify materials with appropriate markings of applicable testing and inspecting agency.

2.3 MATERIALS

A. Batt Insulation: ASTM C 665 mineral fiber blanket insulation.
   1. Unfaced Glass Fiber: Type I (blankets without membrane facing); with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively passing ASTM E 136 for combustion characteristics.
   2. Sound Attenuation Insulation (Sound Batts): Unfaced glass fiber batt insulation as specified above.

B. Substitutions not allowed.

2.4 ACCESSORIES

A. Tape: Polyethylene or polyester self-adhering type; two inches wide.

B. Adhesive: Waterproof type, acceptable to manufacturer of insulation board.

PART 3 - EXECUTION

3.1 PREPARATION

A. Batt Insulation:
   1. Verify adjacent materials are dry and ready to receive installation.
   2. Verify mechanical and electrical services within walls have been installed and tested.

3.2 INSTALLATION - BATT INSULATION

A. Install batt insulation in accordance with manufacturer's instructions, without gaps or voids.

B. Trim insulation neatly to fit spaces. Use batts free of damage. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within the plane of insulation.

C. Install insulation with factory applied membrane facing warm side in winter of building spaces. Lap ends and side flanges of membrane. Attach insulation in place to framing; tape seal butt ends and lapped side flanges. Tape seal tears or cuts in membrane.

3.3 INSTALLATION - INSULATION AT FURRED-OUT CONCRETE WALLS

A. Apply insulation to interior of exterior concrete wall between furring strips where furring is indicated on Drawings.

3.4 SCHEDULES

A. Provide insulation types as scheduled below and as indicated on Drawings.

CONDITION	TYPE OF INSULATION	THICKNESS
Thermal Insulation	Unfaced Batt Insulation	As indicated on Drawings.
Sound Attenuation	Unfaced Batt Insulation	3-1/2 inches or 6 inches as Shown.

END OF SECTION 072100

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Galvanized sheet metal.
   2. Coated aluminum architectural sheet metal flashing.
   3. Manufactured counter-flashing.

1.2 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

PART 2 - PRODUCTS

2.1 SHEET METALS

A. Galvanized Steel: ASTM A 653 Commercial Quality and Lock-Forming Quality, G90 coating designation hot-dip galvanized, mill phosphatized for painting where exposed to view from ground level. Sheet metal gages shall be as shown or as follows where not shown:
   1. Flashing and Counter Flashing: 24 gage.
   2. Fascia and Edge Trim: 24 gage.

B. Coated Aluminum Sheet: .032 gauge.
   1. Topside: Factory finished baked on manufacturer's standard 2-Coat fluoropolymer. Fluoropolymer finish shall be not less than 70 percent Kynar 500 PVDF resin by weight in color coat with a minimum of 0.9 mil total dry film thickness. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions. Provide with protective strippable, temporary film.
      a. Finish: Non-embossed, medium gloss.
      b. Color: As indicated on Drawings.
   2. Underside: Manufacturer's standard white or light-colored acrylic or polyester backer finish.

2.2 UNDERLAYMENT MATERIALS

A. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
   1. Thermal Stability: ASTM D 1970; stable after testing at 240 degrees F.
   2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 degrees F.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and 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.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
   1. Obtain field measurements for accurate fit before shop fabrication.
   2. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
   3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.

B. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant.

C. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

2.5 FINISH

A. Sheet metal finish shall be as shown on Drawings.

B. Where paint finish is shown, field paint in accordance with Section 099000.

C. Sheet metal surfaces not designated or specified to receive a finish shall remain uncoated.

PART 3 - EXECUTION

3.1 UNDERLAYMENT INSTALLATION

A. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches.

B. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

3.2 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 so that completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight. Use fasteners, solder, welding rods, 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 and levels indicated. 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. Anchor each cleat with two fasteners. Bend tabs over fasteners.
   4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
   5. Install sealant tape where indicated.
   6. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
   1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

D. Fastener Sizes: Use fasteners of sizes that will penetrate metal decking not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal joints as shown and as required for watertight construction.

F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
   1. Do not solder metallic-coated steel sheet.
   2. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
   3. Stainless-Steel Soldering: Tin edges of uncoated sheets using solder recommended for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

3.3 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and 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 076200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Section, apply to work specified in this section.

1.2 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 GENERAL DESCRIPTION

A. Only tested firestop systems shall be used in the following specific locations:
   1. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
   2. Blank openings through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
   3. Openings and penetrations in fire-rated partitions or walls containing fire doors.
   4. Openings around structural members which penetrate floors or walls.

1.4 RELATED WORK

A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
   1. Section 033000 - Cast-In-Place Concrete
   2. Section 210000 - Fire Suppression

1.5 REFERENCES

A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops".

B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Firestops".

C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
   1. UL Fire Resistance Directory:
      a. Firestop Devices (XHJI).
      b. Fire Resistance Ratings (BXRH).
      c. Through-Penetration Firestop Systems (XHEZ).

d. Fill, Voids, or Cavity Material (XHHW).
e. Forming Materials (XHKU).

D. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.

E. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.

F. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops."

G. NFPA 101 - Life Safety Code

H. NFPA 70 - National Electric Code

1.6 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide through-penetration fire stop systems that comply with specified requirements of tested systems.

B. Firestop System installation must meet requirements of ASTM E 814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgment derived from similar qualified tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents must follow requirements set forth by the International Firestop Council.

1.7 SUBMITTALS

A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of qualified firestop systems to be used and manufacturer's installation instructions to comply with Section 013000.

B. Submit material safety data sheets provided with product delivered to job-site.

1.8 INSTALLER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A supplier's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

B. Installation Responsibility: assign installation of through-penetration fire stop systems and fire-resistive joint systems in Project to a single sole source firestop specialty contractor.

C. The work is to be installed by a contractor with at least one of the following qualifications:
   1. FM 4991 Approved Contractor
   2. UL Approved Contractor
   3. Hilti Accredited Fire Stop Specialty Contractor

D. Firm with not less than 3 years experience with fire stop installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

A. Do not use materials that contain flammable solvents.

B. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 - PRODUCTS

2.1 FIRESTOPPING – GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Penetrations in Fire Resistance Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
   1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.

D. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
   1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
   2. T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
   3. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.

E. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

F. Mold Resistance: Provide penetration firestoppping with mold and mildew resistance rating of 0 as determined by ASTM G21.

G. Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed." Provide cast-in-place firestop devices prior to concrete placement.

2.2 ACCEPTABLE MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturer as identified below:
   1. Hilti, Inc., Tulsa, OK (800) 879-8000, Website: www.us.hilti.com.

B. Other Acceptable Manufacturers:
   1. Grace Construction Products.
   2. 3M Fire Protection Products.

2.3 MATERIALS

A. Use only firestop products that have been UL 1479 or ASTM E 814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

B. Pre-installed firestop devices for use with noncombustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors and/or gypsum walls, the following products are acceptable as a basis-of-design:
   1. Hilti Cast-In Place Firestop Device (CP 680-P)
      a. Add Aerator Adaptor when used in conjunction with aerator system.
   2. Hilti Cast-In Place Firestop Device (CP 680-M) for use with noncombustible penetrants.
   3. Hilti Firestop Speed Sleeve (CP 653) for use with cable penetrations.

4. Hilti Firestop Drop-In Device (CFS-DID) for use with noncombustible and combustible penetrants.
5. Hilti Firestop Block (CFS-BL).

C. Sealants, caulking materials, or foams for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
1. Hilti Intumescent Firestop Sealant (FS-ONE MAX).
2. Hilti Fire Foam (CP 620).
3. Hilti Flexible Firestop Sealant (CP 606).

D. Sealants or caulking materials for use with sheet metal ducts, the following products are acceptable:
1. Hilti Flexible Firestop Sealant (CP 606).
2. Hilti Intumescent Firestop Sealant (FS-ONE MAX).

E. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe, the following products are acceptable:
1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)

F. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles, the following products are acceptable:
1. Hilti Intumescent Firestop Sealant (FS-ONE MAX).
2. Hilti Fire Foam (CP 620).
3. Hilti Flexible Firestop Sealant (CP 606).

G. Non-curing, re-penetrable, intumescent putty or foam materials for use with flexible cable or cable bundles, the following products are acceptable:
1. Hilti Firestop Putty Stick (CP 618).
2. Hilti Firestop Plug (CFS-PL).

H. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:
1. Hilti Firestop Putty Pad (CP 617).
2. Hilti Firestop Box Insert.

I. Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems), the following products are acceptable:
1. Hilti Firestop Collar (CP 643N).
2. Hilti Firestop Collar (CP 644).
3. Hilti Wrap Strips (CP 648E/648S).

J. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
1. Hilti Firestop Mortar (CP 637).
2. Hilti Firestop Block (CFS-BL).
3. Hilti Fire Foam (CP 620).
4. Hilti Firestop Board (CP 675T).

K. Non curing, re-penetrable materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
1. Hilti Firestop Block (CFS-BL).
2. Hilti Firestop Board (CP 675T).

L. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:
   1. Hilti Firestop Block (CFS-BL).
   2. Hilti Firestop Plug (CFS-PL).

M. Provide a firestop system with a "F" Rating as determined by UL 1479 or ASTM E 814 which is equal to the time rating of construction being penetrated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Verify penetrations are properly sized and in suitable condition for application of materials.
   2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
   3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
   4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
   5. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
   6. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Coordinate construction of openings, penetrations and construction joints to ensure that the fire stop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems. Coordinate construction and sizing of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

C. Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.

D. Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.

E. Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector, per requirements of Section 109, International Building Code 2000, ed.

3.3 INSTALLATION

A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration materials.
   1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
   2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
   3. Protect materials from damage on surfaces subjected to traffic.

3.4 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

E. Manufacturer's Field Services: During Installation, provide periodic destructive testing inspections to assure proper installation/application. After installation is complete, submit findings in writing indicating whether or not the installation of the tested system identified was installed correctly.

3.5 IDENTIFICATION AND DOCUMENTATION

A. The firestop contractor shall supply documentation for each single application addressed. This documentation is to identify each penetration and joint location on the entire project. The Documentation Form for through penetrations shall include the following:
   1. A Sequential Location Number.
   2. The Project Name.
   3. Date of Installation.
   4. Detailed description of the penetrations location.
   5. Tested System or Engineered Judgment Number.
   6. Type of assembly penetrated.
   7. A detailed description of the size and type of penetrating item.
   8. Size of opening.
   9. Number of sides of assemblies addressed.
   10. Hourly rating to be achieved.
   11. Installers Name.

B. The Documentation Form for Construction Joints shall include the following:
   1. A Sequential Location Number.
   2. The Project Name.
   3. Date of Installation.
   4. Detailed description of the construction joint location.
   5. Tested System or Engineered Judgment Number.
   6. Type of construction joint.
   7. A detailed description of the size and type of penetrating item.
   8. The lineal footage of the joint.
   9. Number of sides of assemblies addressed.

10. Hourly rating to be achieved.
11. Installers Name.

C. Copies of these documents are to be provided to the general contractor at the completion of the project.

D. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
1. The words: "Warning -Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's Name, address, and phone number.
3. Through-Penetration firestop system designation of applicable testing and inspecting agency.
4. Date of Installation.
5. Through-Penetration firestop system manufacturer's name.
6. Installer's Name.

3.6 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

3.7 LABOR USE TO INSTALL FIRESTOP SYSTEMS

A. To ensure complete harmony on the project site, the installation of each scope of work is to be performed jurisdictionally correct per existing trade agreements.

END OF SECTION 078413

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Joints in or between fire-resistance-rated constructions.
   2. Joints at exterior wall/floor intersections.
   3. Joints in smoke barriers.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 specification Sections, apply to Work specified in this Section.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.5 INFORMATIONAL SUBMITTALS

A. Product test reports.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 DELIVERY, STORAGE AND HANDLING

A. Transport, handle, store, and protect products in compliance with the requirements of Section 016000 and manufacturer's recommendations.

B. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

C. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job site.

D. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.

E. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

F. Do not use damaged or expired materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
      a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
         1) UL in its "Fire Resistance Directory."

2.2 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Roxul Inc.
      b. Thermafiber, Inc.; an Owens Corning company.
      c. Tremco, Inc.
   2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

C. Joint sealant between pre-cast concrete panels:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Corning: 790 silicone.

D. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

C. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

D. Install sealant materials for fire-resistive joint systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
   2. Apply sealant fill materials so they contact and adhere to substrates formed by joints.
   3. For sealant fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.3 IDENTIFICATION AND DOCUMENTATION

A. The firestop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration and joint location on the entire project.

B. The documentation form for through penetrations shall include the following:
   1. A sequential location number.
   2. The Project name.
   3. Date of installation.
   4. Detailed description of the construction joints location.
   5. Tested system or engineered judgment number.
   6. Type of construction joint.
   7. The width of the joint.
   8. The lineal footage of the joint.
   9. Number of sides addressed.
   10. Hourly rating to be achieved.
   11. Installers name.

C. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

D. Copies of these documents are to be provided to the General Contractor at the completion of the Project.

3.4 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joint to be free of excess firestop materials and soiling as Work progresses.

3.5 LABOR USE TO INSTALL FIRESTOP SYSTEMS

A. To ensure complete harmony of the Project site, the installation of each scope of Work is to be performed jurisdictionally correct per existing trade agreements.

END OF SECTION 078443

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Butyl joint sealants.

B. Related Sections:
1. Division 08 Section "Glazing" for glazing sealants.
2. Division 09 Section "Gypsum Board" for sealing perimeter joints.

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. Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

D. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

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

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.
1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

1.5 PROJECT CONDITIONS

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

1.6 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within manufacturer's standard product lifetime warranty period.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from natural causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. VOC Content of Interior Sealants at Laboratory and Prep Area: Provide zero VOC sealants in these areas.

D. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
   1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

E. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

F. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

G. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
   1. Products: Subject to compliance with requirements provide one of the following:
      a. Dow Corning Corporation.
      b. GE Advanced Materials - Silicones.
      c. Tremco Incorporated.
      d. Pecora.
      e. BASF

B. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant (JS-5): ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pecora Corporation; 898.
      b. Tremco; Tremsil 200.

2.3 SOLVENT-RELEASE-CURING JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealant: ASTM C 1311.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Bostik, Inc.; Chem-Calk 300.
      b. Pecora Corporation; BC-158.
      c. Tremco Incorporated; Tremco Butyl Sealant.

2.4 URETHANE JOINT SEALANTS

A. Single-Component, Nonsag, Urethane Joint Sealant (JS-2): ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following :
      a. Pacific Polymers International, Inc.
      b. Polymeric Systems, Inc.

B. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
   1. Products: Subject to compliance with requirements, provide one of the following :
      a. BASF Building Systems.
      b. Bostik, Inc.; Chem-Calk.
      c. Pecora Corporation
      d. Sika Corporation, Construction Products Division.
      e. Tremco Incorporated.

C. Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant (JS-1): ASTM C 920. Type S, Grade NS, Class 25, for Use T.
   1. Products: Subject to compliance with requirements, provide one of the following :
      a. BASF Building Systems.
      b. May National Associates, Inc.
      c. Pacific Polymers International, Inc.
      d. Sika Corporation, Construction Products Division.
      e. Tremco Incorporated.

D. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant (JS-1): ASTM C 920, Type S, Grade P, Class 25, for Use T.
   1. Products: Subject to compliance with requirements, provide one of the following :
      a. BASF Building Systems.
      b. Bostik, Inc.
      c. May National Associates, Inc.
      d. Pecora Corporation.
      e. Sika Corporation. Construction Products Division.
      f. Tremco Incorporated.

2.5 LATEX JOINT SEALANTS

A. Latex Joint Sealant (JS-3): Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
   1. Products: Subject to compliance with requirements, provide one of the following :
      a. BASF Building Systems.
      b. Bostik, Inc.
      c. Pecora Corporation.
      d. Schnee-Morehead, Inc.
      e. Tremco Incorporated.

2.6 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

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

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.
      b. Masonry.
   3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

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 in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
   4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.

5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
   a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

A. Joint Sealant at Room 204 SCADA: Apply appropriate sealant at perimeter intersection of walls and flooring, and at walls and ACT.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces; JS-1.
   1. Joint Locations:
      a. Joints adjacent to brick.
   2. Urethane Joint Sealant: Single component, nonsag, traffic grade or Single component, pourable, traffic grade.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces; JS-2.
   1. Joint Locations:
      a. Construction joints in cast-in-place concrete.
      b. Joints in brick.
      c. Perimeter joints between materials listed above and frames of doors, windows and louvers.
      d. Control and expansion joints in ceilings and other overhead surfaces.
      e. Other joints as indicated.
   2. Urethane Joint Sealant: Single component, nonsag, Class 50.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces; JS-1.
   1. Joint Locations:
      a. As indicated on Drawings.
   2. Urethane Joint Sealant: Single component, nonsag, traffic grade or Single component, pourable, traffic grade.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces; JS-3.
   1. Joint Locations:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings where indicated.

c. Vertical joints on exposed surfaces of interior unit masonry, concrete, walls and partitions.
d. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
e. Other joints as indicated.

2. Joint Sealant: Latex.

E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal surfaces; JS-4
1. Joint locations: As indicated on Drawings.
a. Polyurethane (security) Joint Sealant

F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces; JS-5.
1. Joint Sealant Location:
a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Joint in food prep areas.
c. Other joints as indicated.
2. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes hollow-metal work.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, and finishes.

B. Shop Drawings: Include the following:
   1. Elevations of each door type.
   2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of anchorages, joints, field splices, and connections.
   7. Details of accessories.
   8. Details of moldings, removable stops, and glazing.
   9. Details of conduit and preparations for power, signal, and control systems.

C. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
   1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Amweld International, LLC.
   2. Apex Industries, Inc.
   3. Ceco Door; ASSA ABLOY.
   4. Commercial Door & Hardware Inc.
   5. Curries Company; ASSA ABLOY.
   6. Republic Doors and Frames.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and 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.

2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3. At locations indicated in the Door and Frame Schedule.
   1. Physical Performance: Level A according to SDI A250.4.
   2. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches.
      c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.053 inch.
      d. Edge Construction: Model 1, Full Flush.
      e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
   3. Frames:
      a. Materials: Uncoated, steel sheet, minimum thickness of 0.053 inch.
      b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
      c. Construction: Face welded.
   4. Exposed Finish: Prime.

2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3. At locations indicated in the Door and Frame Schedule.
   1. Physical Performance: Level A according to SDI A250.4.
   2. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches
      c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
      d. Edge Construction: Model 1, Full Flush.
      e. Core: Manufacturer's standard, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
         1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
   3. Frames:
      a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
      b. Construction: Face welded.
   4. Exposed Finish: Prime.

2.5 BORROWED LITES

A. Hollow-metal frames of metallic-coated steel sheet, minimum thickness of 0.053 inch.

B. Construction: Face welded.

2.6 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. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
   4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:
   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
   2. 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.

2.7 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Glazing: Comply with requirements in Section 088000 "Glazing."

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

2.8 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:
   1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
   2. Fire Door Cores: As required to provide fire-protection ratings indicated.
   3. Vertical Edges for Single-Acting Doors: Provide beveled or square edges at manufacturer's discretion.
   4. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.
   5. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
   6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
   7. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
   1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
   2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
   3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
   4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
   5. Jamb Anchors: Provide number and spacing of anchors as follows:
      a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:

1) Two anchors per jamb up to 60 inches high.
2) Three anchors per jamb from 60 to 90 inches high.
3) Four anchors per jamb from 90 to 120 inches high.
4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
1) Three anchors per jamb up to 60 inches high.
2) Four anchors per jamb from 60 to 90 inches high.
3) Five anchors per jamb from 90 to 96 inches high.
4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.

c. Compression Type: Not less than two anchors in each frame.

d. 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.

6. Head Anchors: Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.

7. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted 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 glazing and installation types indicated.

2.9 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.10 ACCESSORIES

A. Louvers: Provide louvers for interior doors, where indicated, which comply with SDI 111C, with blades or baffles formed of 0.020-inch-thick, cold-rolled steel sheet set into 0.032-inch-thick steel frame.
   1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
   2. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other.
   3. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.

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

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
    a. At fire-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable stops located on secure side of opening.
    d. Install door silencers in frames before grouting.
    e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    g. Field apply bituminous coating to backs of frames that will be 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 power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
5. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.
8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Steel Doors:
    a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
    b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
    c. At Bottom of Door: 5/8 inch plus or minus 1/32 inch.
    d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "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.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. 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.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Solid-core doors with wood-veneer hardboard or MDF faces.
   2. Factory finishing flush wood doors.
   3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 ACTION 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 factory-finished doors.

1.3 QUALITY ASSURANCE

A. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated."

B. 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 as close to neutral pressure as possible according to NFPA 252.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Buell Door Company Inc.
   2. Graham; an Assa Abloy Group company.
   3. Haley Brothers, Inc.
   4. Ideal Architectural Doors & Plywood.
   5. Oshkosh Architectural Door Company.

6. Vancouver Door Company.
7. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

A. WDMA I.S.1-A Performance Grade:
   1. Heavy Duty unless otherwise indicated.

B. Particleboard-Core Doors:
   1. Particleboard: ANSI A208.1, made with binder containing no urea-formaldehyde resin.
   2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.

C. 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.

D. 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.
   2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

E. Mineral-Core Doors:
   1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
   2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
   3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:
   1. Grade: Premium, with Grade A faces.
   2. Species: Match existing.
   3. Cut: Rift cut.
   4. Match between Veneer Leaves: Pleasing match.
   5. Assembly of Veneer Leaves on Door Faces: Balance match.
   6. Pair and Set Match: Provide for doors hung in same opening.
   7. Core: Either glued wood stave or structural composite lumber.
   8. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering.
   9. Construction: Seven plies, either bonded or non-bonded construction.

2.4 LOUVERS AND LIGHT FRAMES

A. Metal Louvers:
   1. Metal and Finish: Extruded aluminum with Class II, clear anodic finish, AA-M12C22A31.

B. Metal F s for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of frame 0.048-inch-thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.5 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   1. Comply with requirements in NFPA 80 for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

C. Openings: Cut and trim openings through doors in factory.
   1. Louvers: Factory install louvers in prepared openings.

2.6 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 bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory that are indicated to receive transparent finish. Field finish doors indicated to receive opaque finish.

C. Transparent Finish:
   1. Grade: Premium.
   2. Finish: AWI conversion varnish or catalyzed polyurethane.
   3. Staining: Match existing.
   4. Effect: Semi-filled finish, produced by applying an additional finish coat to partially fill the wood pores.
   5. Sheen: Satin.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hardware: For installation, see Section 08 71 00 "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. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine

doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
    a. Comply with NFPA 80 for fire-rated doors.

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

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Non-fire rated access doors and frames for walls and ceilings.

1.2 QUALITY ASSURANCE

A. Perform Work in accordance with UL requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide access doors by one of the following manufacturers:
   1. Acudor Products, Inc., Fairfield, NJ. (800) 722-0501.

B. Substitutions: Not Permitted.

2.2 STEEL MATERIALS

A. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A 879 with cold-rolled steel sheet substrate complying with ASTM A 1008, Commercial Steel (CS), exposed.

B. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS) with A60 zinc-iron-alloy (galvannealed) coating or G60 mill-phosphatized zinc coating.

C. Drywall Beads: 0.0299-inch zinc-coated steel sheet to receive joint compound.

D. Manufacturer's standard finish factory primed finish.

2.3 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Flush Access Doors and Frames
   1. Fabricated from steel sheet
   2. Exposed Trim Type:
      a. Model ED-2002 by Acudor.
   3. Locations: Wall and ceiling.
   4. Door: Minimum 0.060-inch- thick sheet metal.
   5. Frame: Minimum 0.060-inch- thick sheet metal with 1-1/4-inch- wide, surface-mounted trim.
   6. Hinges: Spring-loaded, concealed-pin type or continuous piano.
   7. Latch: Cam latch with interior release. Provide latch for all units unless specified to have locks.
   8. Lock: Cylinder with 2 keys. Provide lockable cylinders as follows:
      a. Exterior locations.
   9. Units larger than 24 inches on the hinge side shall have two locks or latches.

2.4 FINISH

A. Base Metal Protection: Factory prime coat units with electrostatic baked on electrostatic powder. For ceiling units, prime exposed edges with coat of rust-inhibitive paint.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify rough openings for door and frame are correctly sized and located.

B. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install units plumb, square and flush with adjacent ceiling or wall surface. Secure rigidly in place.

C. Position to provide convenient access to concealed work requiring access.

3.3 ACCESS DOOR SCHEDULE

A. Provide access door and frame suitable for the application.

B. Install trimless access door and frame in interior gypsum board walls and ceilings and other locations suitable and adaptable for trimless installation

C. Install exposed trim access door and frame where at exterior locations and where impractical to install trimless installation.

D. Install access doors in ceilings and walls in locations as shown on the Drawings, at valves, controls, and manual dampers requiring access, and as required by code and governing authorities.

END OF SECTION 083113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Mechanical door hardware for the following:
      a. Swinging doors.

1.2 SUBMITTALS

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

B. Samples: For each product and for finish specified.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

B. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
   1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
   2. Comply with the following maximum opening-force requirements:
      a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, store, and protect door hardware products in compliance with the requirements of Section 016000 and manufacturer's recommendations.

B. Product Packaging: Products will be shipped in manufacturer's standard packaging with identification markings on each component or package.

C. Store products in unopened packages in protected dry area to prevent damage from environmental and construction operations.

D. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide hardware as scheduled in Hardware Schedule in Part 3 of this Section.

B. Product Designations: Hardware may be any of the products listed within the tables below for each specific type. Substitutions will not be permitted.

C. Hardware Manufacturer Designations:

ID	Manufacturer	Telephone	ID	Manufacturer	Telephone
Ar	Arrow (ASSA ABLOY)	(800) 233-0478	Re	Reese Enterprises, Inc.	(800) 328-0953
De	Detex Corporation	(800) 729-3839	Ri	Rixson (ASSA ABLOY)	(800) 457-5670
GJ	Glynn-Johnson	(800) 525-0336	Ro	Rockwood (ASSA ABLOY)	(814) 926-2026
H	Hager Companies	(800) 325-9995	Sc	Schlage	(800) 847-1864
I	H. B. Ives	(877) 613-8766	Sec	Securitron (ASSA ABLOY)	
LCN	LCN Closers	(800) 526-2400	Sel	Select Hinges	(800) 423-1174
Mc	McKinney (ASSA ABLOY)	(717) 346-7551	S	Stanley Hardware	(800) 622-4393
NG	National Guard Products, Inc.	(800) 647-7874	T	Trimco (Triangle Brass Mfg)	(800) 637-8746
P	Pemko Mfg. Co.	(805) 642-2600	VD	Von Duprin	(800) 999-0408
Po	Positive Lock	(800) 342-7670			

2.2 REGULATORY REQUIREMENTS

A. Perform work in accordance with the following standards:
1. ANSI A117.1
2. NFPA 101.
3. NFPA 80.
4. NFPA 252.
5. UL 10B.
6. UL 305.

B. Conform to applicable code for requirements applicable to fire rated doors and frames.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. (UL), and acceptable to Authority Having Jurisdiction as suitable for the purpose specified and indicated.

D. Conform to applicable local, State or Federal disabled access requirements for the installation and operation of door hardware.

2.3 FINISHES

A. Provide finishes as specified in Part 2 of this Section unless otherwise indicated in the Hardware Schedule for the specific hardware item.

2.4 HINGES

A. Material:
1. Continuous Geared Hinge: Full surface type hinge of 6063 T6 Aluminum with thermoplastic polyester bearings, 90 min. fire rated, clear finish. Provide self drilling threaded fasteners for frame and thru bolts for door.

B. Hinges by types:

Type	Description	Finish	MANUFACTURER/MODEL		
			Select Hinge	Hager	Pemko
H-1	Hinge: Continuous geared hinge	CL	SL21 SD x SDTF x FDH	Roton 780-210	CFS
			Stanley	Hager	McKinney
H-2	Butts: Medium weight, stainless steel	630	FBB191	BB1191	TB3386

A. Electromagnetic Door Holders by types:

Type	Description	Finish	MANUFACTURER/MODEL	
			LCN	Rixson
DH-1	Door Holder	689	SEM 7850 689	FM-998 SA

2.5 THRESHOLDS

A. Thresholds by types:

Type	Description	MANUFACTURER/MODEL		
		Pemko		
T-1	Threshold: Stainless steel 5 inches x 1/2 inch, abrasive (Clean Room).	154SS		
		National Guard	Pemko	Reese
T-2	Threshold: 5 inches, aluminum, stop seal	896S	2005AT	S483AS

2.6 LOCKS, LATCHES, AND BOLTS

A. Materials:
1. Cylindrical Locks: ANSI A 156.2, Series 4000 Grade 1 or 2 as scheduled, equipped with 7 pin tumbler Brass Small Format Interchangable construction cores (SFIC); "keyed alike". Provide 2-3/4 inch backset.
2. Provide six construction keys total for the project.
3. Owner will maintain control keys for temporary core removal & permanent core installation.
4. Final keying will be coordinated by the Owner.

5. Upon completion of permanent core installation all keys, including control key will be turned over to the Owner.
6. Strikes: ANSI Strikes, 1-1/4 x 4-7/8 inches, with curved lip. Wrought box strikes, with extended lip for latch bolts, except open strike plates may be used in wood frames. Provide dustproof strikes for foot bolts.
7. Tactile Warning: Provide locks with tactile warning for handicapped codes when required by Authority Having Jurisdiction.

B. Locks by types:

Type	Description	Finish	MANUFACTURER/MODEL
			Schlage
L-1	Office Lock (F82)	626	ND50BD-Rhodes-10-025 SFIC Lock Less Core
L-2	Construction Core	TBD	Brass Construction Core, 7 Pin.

2.7 EXIT DEVICES

A. Materials:
1. Provide exposed metal to match hardware.
2. Size and mount units indicated or, if not indicated, to comply with manufacturer's recommendations for exposure condition. Reinforce substrate as recommended.

B. Exit Devices by types:

Type	Description	Finish	MANUFACTURER/MODEL
			Von Duprin unless otherwise noted.
E-1	Exit Device: Rim, lever trim, UL Listed	626	99L-F-992L-NL

2.8 CLOSERS

A. Materials & Features:
1. ANSI A 156.4, grade 1.
2. ADA/ANSI A117.1
3. UL listed.
4. Non-handed, non-sized; adjustable 1-6.
5. 180 degree door opening.
6. Standard cover.
7. Multiple backcheck location valve.
8. Extreme temperature fluid.
9. Sex nuts and bolts (SNBs).
10. Provide exposed metal to match hardware.
11. Size and mount units indicated or, if not indicated, to comply with manufacturer's recommendations for exposure condition. Reinforce substrate as recommended.

B. Closers by types:

Type	Description	Finish	MANUFACTURER/MODEL
			LCN
C-1	Closer: Parallel Arm, positive stop	689	4111-CUSH

2.9 STOPS, HOLDERS AND BUMPERS

A. Materials:
   1. Door stop mounting: Methods to suit substrates encountered (plastic anchor, drywall anchor, expansion shield).
   2. Provide gray rubber exposed resilient parts.
   3. Do not furnish aluminum floor stops.
   4. Adjust height of floor stops to suit undercut of adjacent door.

B. Stops, Holders and Bumpers by types:

Type	Description	Finish	MANUFACTURER/MODEL		
			Ives	Trimco	Rockwood
S-1	Wall Stop	630	WS407CVX	W1276CS	409
S-2	Floor Stop	630	FS13	1211	RM855

2.10 WEATHERSTRIPPING

A. Weatherstripping by types:

Type	Description	MANUFACTURER/MODEL		
		National Guard	Pemko	Reese
W-1	Jamb Door Gaskets, adhesive application, silicone seal.	5050B	S88D	797B
		Pemko		
W-2	Door Bottom Sweep (Clean Room)	321SSN		
W-3	Perimeter Gasketing (Clean Room)	332SSR		
		National Guard	Pemko	Reese
W-4	Door Bottom Sweep, surface mounted sweep, anodized aluminum, neoprene seal	201NA	315CN	323A
W-5	Jamb Door Gaskets, adhesive application, silicone seal	5050B	S88D	797B

2.11 MISCELLANEOUS HARDWARE

A. Silencers: Provide in metal door frames, unless not permitted for fire rating, or unless bumper-type weatherstripping is provided; three for each single door frame, two for double-door frame.

B. Miscellaneous Hardware by types:

Type	Description	Size	Finish	MANUFACTURER/MODEL		
				Ives	Trimco	Rockwood
M-1	Silencers			SR64	1229-A	608
				National Guard	Pemko	Reese
M-2	Drip Cap			16A	346CxFW	R201A

2.12 FABRICATION

A. Finish and Base Material Designations: Number indicates Builders Hardware Manufacturer's Association (BHMA) Code or nearest traditional U.S. commercial finish.

B. Where base material and quality of finish are not otherwise indicated, provide at least commercially recognized quality.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
   1. Fire-Rated Applications:
      a. Wood or Machine Screws: For the following:
         1) Hinges mortised to doors or frames.
         2) Strike plates to frames.
         3) Closers to doors and frames.
      b. Steel Through Bolts: For the following unless door blocking is provided:
         1) Surface hinges to doors.
         2) Closers to doors and frames.
         3) Surface-mounted exit devices.
   2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
   3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that doors and frames are ready to receive Work and dimensions are as instructed by the manufacturer.

3.2 INSTALLATION

A. Hardware Mounting Heights: Door and Hardware Institute Recommended Locations for Builders Hardware for Standard Steel Doors and Frames, except as otherwise indicated.
   1. Conform to requirements of applicable local, State or Federal disabled access requirements for the installation and operation of door hardware.

B. Install each hardware item to comply with manufacturer's instructions and recommendations, unless otherwise specified.

C. Thru-bolt closers on doors.

3.3 FIELD QUALITY CONTROL

A. Field quality control shall be the ultimate responsibility of the Contractor. Field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements.

3.4 ADJUSTING

A. Hardware Adjustment: Adjust hardware for proper operation and function one month after Substantial Completion. Instruct Owner's personnel in proper maintenance and adjustment.

3.5 HARDWARE SCHEDULE

Door 201 – Office: HM, Single, UL Label

1 ea.	H-1	Continuous Geared Hinge
1 ea.	L-1	Office Lockset
1 ea.	L-2	Construction Core
1 ea.	C-1	Closer
1 ea.	S-1	Wall Stop
1 set	W-1	Door Gaskets

Door 202 – Office: HM, Single, UL Label

1 ea.	H-1	Continuous Geared Hinge
1 ea.	L-1	Office Lockset
1 ea.	L-2	Construction Core
1 ea.	C-1	Closer
1 ea.	S-1	Wall Stop
1 set	W-1	Door Gaskets

Door 203 – Office: HM, Single, UL Label

1 ea.	H-1	Continuous Geared Hinge
1 ea.	L-1	Office Lockset
1 ea.	L-2	Construction Core
1 ea.	C-1	Closer
1 ea.	S-1	Wall Stop
1 set	W-1	Door Gaskets

Door 204 – SCADA: HM, Single

1 ea.	H-1	Continuous Geared Hinge
1 ea.	L-1	Office Lock
1 ea.	L-2	Construction Core
1 ea.	S-1	Wall Stop
3 ea.	M-1	Silencers
1 ea.	T-1	Threshold
1 ea.	W-2	Door Bottom Sweep
1 ea.	W-3	Perimeter Gasketing
1 ea.	C-1	Closer
1 ea.	DH-1	Electromagnetic Door Holder

Door by new electrical panel: existing

1ea.	S-2	Floor Stop

Door 205A – Training Room: HM, Single, w/ Exit Device, UL Label

1-1/2 pr.	H-2	Butts
1 ea.	E-1	Exit Device
1 ea.	L-2	Construction Core
1 ea.	C-1	Closer
1 ea.	T-2	Threshold
1 ea.	W-4	Door Bottom Weatherstrip
1 ea.	M-2	Drip Cap
1 ea.	W-5	Door Gasket

Door 205B – Training Room: HM, Single, w/ Exit Device, UL Label

1-1/2 pr.	H-2	Butts
1 ea.	E-1	Exit Device
1 ea.	L-2	Construction Core
1 ea.	C-1	Closer
1 ea.	T-2	Threshold
1 ea.	W-4	Door Bottom Weatherstrip
1 ea.	M-2	Drip Cap
1 ea.	W-5	Door Gasket

Door 301 – Corridor: Relocated Door. Use existing hardware.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Glass for windows, doors, and exterior and interior storefront framing.
   2. Glazing sealants and accessories.

1.2 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

A. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
   1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

1.6 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to 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.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Glass Product: Subject to compliance with requirements, provide product indicated in glass schedules or comparable product by one of the following:
   1. AGC Glass Company North America, Inc.
   2. Oldcastle BuildingEnvelope.
   3. Pilkington North America Inc.
   4. PPG Industries, Inc.
   5. Viracon, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the International Building Code and ASTM E 1300.
   1. Design Wind Pressures: As indicated on Drawings.
   2. Design Snow Loads: As indicated on Drawings.
   3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

B. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2/6.3 computer program, expressed as Btu/sq. ft. x h x deg F.
   2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2/6.3 computer program.
   3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

D. Glass Strength: Analysis shall comply with ASTM E 1300 Determining Load Resistance of Glass in Buildings. Provide glass products in the thickness and strengths (annealed or heat-treated) required to meet or exceed the following criteria based on project loads and in-service conditions.

1. Minimum thickness of annealed or heat-treated glass products to be selected so the worst case probability of failure does not exceed the following:
2. 8 breaks per 1000 for glass installed vertically or not 15 degrees or more from the vertical plane and under wind action.
3. 1 break per 1000 for glass installed 15 degrees or more from the vertical plane and under action of wind and/or snow.
4. Deflection must be limited to prevent disengagement from the frame and be less than or equal to 1" (25mm).

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
   1. GANA Publications: "Glazing Manual."
   2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) or condition B (one surface coated), Type I, Class 1 (clear), Quality-Q3.
   a. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   b. Heat Treated Flat Glass to be by horizontal (roller hearth) process with inherent rollerwave distortion parallel to the bottom edge of the glass as installed.
   c. Maximum peak to valley rollerwave 0.003" (0.08mm) in the central area and 0.008" (0.20mm) within 10.5" (267mm) of the leading and trailing edge
   d. For clear or low-iron glass 1/4" to 3/8" thick without ceramic frit or ink, maximum + or – 100 mD (millidiopter) over 95% of the glass surface.
   e. Maximum bow and warp 1/32" per lineal foot (0.79mm).
   f. All tempered architectural safety glass shall conform with ANSI Z97.1 and CPSC 16 CFR 1201.
   g. For all fully tempered glass, provide heat soak testing conforming to EN14179 which includes a 2 hour dwell at 290°C±10°C.

2.5 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
   1. Sealing System: Dual seals.
      Spacer: Manufacturer's standard spacer material and construction
   2. The unit overall thickness tolerance shall be -1/16" (1.59mm) / +1/32" (0.79mm) for a 1" two ply insulating unit. Unit constructed with patterned or laminated glass shall be +/- 1/16" (1.59mm).
   3. Shall comply with ASTM E 546 Standard Test Method for Frost Point of Sealed Insulating Glass Units
   4. Shall comply with ASTM E 576 Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position
   5. Sealed Insulating Glass Units to be double sealed with a primary seal of polyisobutylene and a secondary seal of silicone.
      a. The minimum thickness of the secondary seal shall be 1/16" (1.59mm).
      b. The target width of the primary seal shall be 5/32" (3.97mm).
      c. There shall be no voids or skips in the primary seal.
      d. Up to a maximum of 3/32" of the airspacer may be visible above the primary polyisobutylene sealant.
      e. Gaps or skips between primary and secondary sealant are permitted to a maximum width of 1/16" (1.59mm) by maximum length of 2" (51mm) with gaps separated by at least 18" (457mm). Continuous contact between the primary seal and the secondary seal is desired.
      f. provide a hermetically sealed and dehydrated space, lites shall be separated by a spacer with bent corners and straight butyl injected zinc plated steel straight key joints.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

B. Setting Blocks: 100% Silicone with a Shore, Type A durometer hardness of 85, plus or minus 5.

C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

E. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. 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.

D. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

E. Provide spacers for glass lites where length plus width is larger than 50 inches.

F. 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.

3.2 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.3 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.4 MONOLITHIC GLASS SCHEDULE

A. Glass Type single-pain: Clear annealed or fully tempered float glass.
   1. Minimum Thickness: 1/4" [6mm].
   2. Safety glazing required.

3.5 INSULATING GLASS SCHEDULE

A. Glass Type double pane: Low-E-coated, tinted insulating glass.
   1. Basis-of-Design Product:
      a. OB: 1/4" PPG Solarbronze High Performance Tint.
      b. AS: 1/2 inch (Air Fill).
      c. IB: 1/4" PPG Sungate 400 on Clear Low-E #3.

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel framing systems for interior partitions.
   2. Suspension systems for interior ceilings and soffits.
   3. Wall furring.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, store, and protect products in compliance with the requirements of Section 016000.

B. Protect metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

C. Store and protect metal framing with weatherproof covering, and ventilate to avoid condensation.

D. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

PART 2 - PRODUCTS

2.1 FRAMING MATERIALS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   1. ClarkDietrich Building Systems, West Chester, OH (513) 870-1100.
   2. The Steel Network, Durham, NC (888) 474-4876.
   3. Cemco Steel, Ft. Worth, TX (817) 568-1525.
   4. Telling Industries, LLC Willoughby, OH (866) 372-6384.
   5. Marino/WARE, South Plainfield, NJ (800) 627-4661.
   6. Other manufacturers listed as a member of CSSA, SSMA or SFIA.

B. Interior Nonload-Bearing Partition Framing: ASTM C 645 and C 754; galvanized sheet steel, channel shaped, punched for utility access, depth and gages as indicated below unless otherwise indicated on Drawings.
   1. Partition having an unbraced length of 12 feet or Less: Minimum 25 gage (18 mil).
   2. Partition having an unbraced length greater than 12 Feet: Minimum 20 gage (30 mil).

3. Partition (bulkheads) suspended from overhead having an unbraced length of 10 Feet or Less: Minimum 25 gage (18 mil).
4. Partition height 8 feet and less: Minimum 25 gage (18 mil).
5. Partition height 8 - 16 feet: Minimum 22 gage (27 mil)
6. Partition height 16 feet and higher: Minimum 20 gage (30 mil).

C. Contractor's Option: In lieu of traditional framing members, Contractor may use modified framing members of equivalent thickness for 20 and 25 gage metal such as ProSTUD Drywall Framing System by ClarkDietrich or comparable framing members by other manufacturers listed as members of CSSA, SSMA, or SFIA.

D. Partition Floor Tracks and Runners: ASTM C 645; galvanized sheet steel, channel shaped, same depth and gage as studs, tight fit; solid web.

E. Deflection (Capture) Track: ASTM C 645; deep-leg U-shaped steel track at roof deck or structure, of web depth as shown to contain studs while allowing free vertical movement indicated.
1. Contractor's Option: One of the following manufacturer's standard double or single deflection tracks modified as required for web depth as shown:
   a. VertiClip or VertiTrack by The Steel Network. If this option is used, track may be 20 guage (30 mil) for all stud sizes.
   b. FastTop Clip by ClarkDietrich.
   c. SLP-TRK by Brady Innovations as distributed by ClarkDietrich.
   d. Comparable modified deflection tracks by other manufacturers listed as members of CSSA, SSMA, or SFIA.

F. Furring and Bracing: ASTM C 645; galvanized sheet steel.
1. Studs: ST25 - 2-1/2 inch deep, 25 gage (18 mil).
2. Studs: ST25 - 3-5/8 inch deep, 25 gage (18 mil).
3. Resilient Furring Channels: 1/2 inch deep x 2-1/2 inch wide, 25 gage (18 mil)
4. Hat-Shaped Channels: 7/8 inch deep x 1-1/2 inch wide, 25 gage (18 mil) or 1-1/2 inch deep x 2-1/2 inch wide (30 mil) as shown on the drawings.
5. Cold-Formed Channels: 3/4 x 1/2 inch and 1-1/2 x 17/32 inch, 16 gage (54 mil).
6. Z Furring Channel: 1-1/2 inch deep, 25 gage (18 mil).
7. Clip Angles: 2 inches x 2 inches x 16 gage (54 mil) x 1/4 inch less than stud width.
8. Contractor's Option: In leiu of cold-formed channels and clip angles for horizontal wall bridging, Contractor may provide one of the following:
   a. Bridge Bar by The Steel Network.
   b. TradeReady Spazzer 9200 Bridging and Bracing Bar by ClarkDietrich.
   c. Comparable products by other manufacturers listed as members of CSSA, SSMA, or SFIA.

G. Ceiling Joists and Runners: Galvanized sheet steel, C-shaped.

H. Partition Framing Fasteners: Corrosion-resistant self-drilling self-tapping steel screws.
1. 22 Gage (27 mil) Framing: ASTM C 1002; 3/8 inch Type S pan head.
2. 20 Gage (30 mil) and Heavier Framing: ASTM C 954; 5/8 inch Type S-12 low-profile head.

I. Bracing to Framing Attachment Angle Fasteners: #12 diameter pan head corrosion-resistant self-drilling screws.

J. Partition Floor Track Anchorage Device: Low velocity powder-actuated drive pins; minimum 0.138 inch shank diameter x 1-1/2 inch shank length with 7/8 inch diameter washer.
1. Hilti PAT System using X-C 37 P8S36 Pins, by Hilti, Tulsa, OK. (800) 879-8000.

2. Ramset/Red Head System using 1500SD Pins, by ITW Ramset/Redhead, Wood Dale, IL (630) 350-0370.

K. Wall Furring to Concrete Wall Fasteners: Hex head sleeve anchors; minimum 1/4 inch diameter x minimum 1-1/8 inch embedment.
   1. Slv Anch HLC-HX 5/16 x 2-5/8, by Hilti, Tulsa, OK (800) 879-8000.
   2. Dynabolt HN-1413, by ITW Ramset/Redhead, Wood Dale, IL (708) 350-1558.

L. Furring Channel to Concrete Surface Fasteners: Low velocity powder-actuated drive pins of size to suit application.

M. Flat Straps and Plates: ASTM A 653; galvanized sheet steel, gage, shape, and configuration as indicated on Drawings.
   1. Contractor's Option: In lieu of 2-inch continuous metal strap at deflection tracks, Contractor may provide one of the following:
      a. Bridge Bar by The Steel Network.
      b. TradeReady Spazzer 9200 Bridging and Bracing Bar by ClarkDietrich.
      c. Comparable products by other manufacturers listed as members of CSSA, SSMA, or SFIA.

N. Suspension System:
   1. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, double strand of 16 ga wire.
   2. Wire Hangers: ASTM A 641/A, Class 1 zinc coating, soft temper, 8 ga.
   3. Carrying Channels: ASTM C 645; galvanized sheet steel, 1-1/2 x 17/32 inch, 16 gage (54 mil).
   4. Furring Channels: ASTM C 645; galvanized, hat-shaped, rigid furring channels, 7/8 inch deep.
   5. Furring Channel Clips: ASTM C 645; galvanized sheet steel, 1-1/2 inch.

PART 3 - EXECUTION

3.1 INTERFACE WITH OTHER WORK

A. Coordinate erection of studs with hollow metal door frames.

B. Coordinate installation of anchors, supports, and blocking for mechanical, electrical, and building accessory items installed within framing.

3.2 INSTALLATION - STEEL FRAMING, GENERAL

A. Installation Standards: Comply with ASTM C 754, and ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with United States Gypsum's "Gypsum Construction Handbook."

3.3 INSTALLATION - PARTITION FRAMING

A. Install studs and fasteners in accordance with manufacturer's published instructions, ASTM C 754, GA-216, and GA-600.

B. Install bracing at terminations in assemblies.

C. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

D. Install studs so flanges within framing system point in same direction.

E. Metal Stud Spacing: Unless otherwise noted, provide interior framing at maximum 24 inches on center. Provide 16 inches on center maximum spacing for walls to receive ceramic tile.

F. Align stud web openings horizontally.

G. Splice studs with minimum 8 inch nested lap, fasten each stud flange with minimum two screws.

H. Construct corners using minimum three studs.

I. Double stud at wall openings, door and window jambs, maximum 2 inches from each side of openings.

J. Place studs as indicated on Drawings, minimum 2 inches from abutting walls.

K. Install headers at partition openings using load-bearing C-shaped joists.

L. Install framing between studs for attachment of mechanical and electrical items.

M. Install intermediate studs above and below openings to match wall stud spacing.

N. Install tracks (runners) at floors and overhead supports. Refer to Drawings for indication of partitions extending to finished ceiling only and for partitions extending through ceiling to building structure above.

O. Maintain clearance under structural members to avoid deflection transfer to studs.
   1. Where indicated, construct partition to accommodate vertical deflection.
   2. Install optional products by The Steel Network specified in Part 2 above in accordance with manufacturer's printed instruction.
      a. Install clip with step bushing in center of slotted hole.
      b. Use a minimum of two fasteners per clip leg to connect clip to structure and partition framing.
      c. Attach clip to each stud by screwing through the center of each step bushing.

P. Fasten studs adjacent to door and window frames, partition intersections, and corners to top and bottom runner flanges in double-stud fashion with metal lock fastener tools.
   1. Securely fasten studs to jamb and head anchor clips of door and borrowed-light frames.
   2. Place horizontally a cut-to-length section of runner with web-flange bend at each end. Fasten with minimum one screw per flange.
   3. Position a cut-to-length stud (extending to top runner) at vertical panel joints over door frame header.

Q. Lateral Bracing for Metal Studs:
   1. In metal stud partitions and bulkheads where length of metal studs is over 8 feet, install lateral bracing using one of the following methods:
      a. Install 1-1/2 inch cold-rolled channel through stud web holes and screw attach in place with clip angles. Lap channels by nesting one inside the other to a depth of at least 8 inches and wire tie together.
      b. Install optional Bridge Bar by the Steel Network specified in Part 2 above in accordance with the manufacturers printed instructions.
      c. Install field-cut runner for solid bridging at each end of wall, adjacent to wall openings, and 10 feet on center maximum. Install 1-1/2 inch wide, 20 gage (30 mil) strap bracing on both sides of stud. Fasten strap bracing to each solid bridging runner section with four screws.
   2. Gypsum Board Partitions: Space lateral bracing at the following intervals:
      a. Partitions Greater Than 8 Feet and Up To 12 Feet In Height: Provide bracing at midpoint.
      b. Partitions Greater Than 12 Feet and Up To 18 Feet In Height: Provide bracing at third points.
      c. Partitions Greater Than 18 Feet and Up To 24 Feet In Height: Provide bracing at quarter points.

R. Install braced framing of steel stud framing as indicated on Drawings. Use only screw attachments.

S. Blocking: Screw attach wood blocking between studs. Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories and hardware.

T. Framing Fastening: Fasten framing in accordance with manufacturer's published instructions and schedule below, unless indicated otherwise on Drawings.

Connection	Fastener
Floor Track to Concrete	1 - Pin at 32 inches on center
Partition Stud to Floor Track	1 - Screw each side at each flange
Stud Brace Web to Stud Web	2 - Screws
Plates and Straps to Studs	2 - Screws
Stud Web to Stud Web	2 - Screws
Stud Brace Web to Attachment Angle	2 - Screws
Lateral Bracing to Partition Stud Using Clip Angles	2 - Screws to stud and 2 - Screws to cold rolled channel
Runner to Header	1 - Screw at 16 inches on center, maximum 6 inches from each end

3.4 INSTALLATION - SUSPENDED CEILING

A. Unless otherwise shown, install suspended ceilings in accordance with the following requirements.

B. Suspend ceiling hangers from building structure as follows:
   1. Install carrying channels 4 feet on center with hanger wire spaced a max of 4 feet on center along carrying channels. Attach furring channels spaced 16 inches on center perpendicular to carrying channels with double strand of saddle tied tie wire or furring channel clips. Apply 5/8 inch gypsum board with its long dimension at right angles to the furring channels. Attach gypsum board with 1 inch self drilling drywall screws 12 inches on center in the field of the board 8 inches or 12 inches on center at butt joints, located not more than 1/2 inch from edges.
   2. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacing that interferes with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
   4. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
   5. Do not attach hangers to steel deck tabs.
   6. Do not attach hangers to steel roof deck. Attach hangers to structural members.
   7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

C. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.

D. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

3.5 INSTALLATION - FURRING

A. Furring Channels:
   1. Attach vertically spaced at maximum 16 inches on center, to masonry and concrete surfaces with hammer set or powder driven fasteners staggered 24 inches on center on opposite flanges.
   2. Nest channels 8 inches at splices and anchor with 2 fasteners in each wing.

B. Wall Furring:
   1. Secure top and bottom runners to structure.
   2. Space metal studs at maximum 16 inches on center.

3.6 FIELD QUALITY CONTROL

A. Inspect metal framing erection, placement, spacing, fasteners, and connections to building.

3.7 PROTECTION

A. Protect installed interior non load-bearing steel stud partition framing from damage until Substantial Completion.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior gypsum board.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

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.

2.2 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. American Gypsum.
   2. CertainTeed Corp.
   3. Georgia-Pacific Gypsum LLC.
   4. Lafarge North America Inc.
   5. National Gypsum Company.
   6. Temple-Inland.
   7. USG Corporation.

B. Standard Gypsum Board: ASTM C 1396.
   1. Thickness: 5/8 inch.
   2. Length, Long Edges, Cut: Maximum permissible length, edges tapered, ends cut square.
   3. Provide one of the following products:
      a. Gypsum Wallboard by American Gypsum.
      b. Sheetrock by United States Gypsum.
      c. CertainTeed Regular Gypsum Board by Certainteed.
      d. ToughRock Gypsum Board by Georia-Pacific.
      e. Gold Bond Gypsum Board by National Gypsum.

C. Fire Resistant Gypsum Board: ASTM C 1396, Type X.
   1. Thickness: 5/8 inch.
   2. Length, Long Edges, Cut: Maximum permissible length, edges tapered, ends cut square.
   3. Provide one of the following products:
      a. FireBloc Type X by American Gypsum.
      b. Sheetrock Firecode X by United States Gypsum.
      c. CetainTeed Type X Gypsum Board by Certainteed.
      d. ToughRock Fireguard X by Georgia-Pacific.
      e. Gold Bond Fire Shield by National Gypsum.

D. Water Resistant Gypsum Board: ASTM C 1396, Type X.
   1. Thickness: 5/8 inch.
   2. Length, Long Edges, Cut: Maximum permissible length, edges tapered, ends cut square.
   3. Core: Moisture or mold resistant gypsum core.
   4. Mold Resistance: Score of 10 in accordance with ASTM 3273/3274.
   5. Provide one of the following products:
      a. M-Bloc Mold and Moisture Resistant by American Gypsum.
      b. Sheetrock Brand Mold Tough by United States Gypsum.
      c. Gold Bond Brand XP Gypsum Board by National Gypsum.
      d. ToughRock Mold-Guard Gympsum Board by Georgia-Pacific.
      e. M2Tech Gypsum Board by Certainteed.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Exterior Gypsum Soffit Board: Paper.
   3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
   4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.5 AUXILIARY MATERIALS

A. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

B. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).

C. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
b. Grabber Construction Products; Acoustical Sealant GSC.
c. Pecora Corporation; AC-20 FTR.
d. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
e. USG Corporation; SHEETROCK Acoustical Sealant.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Acoustical joint 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."

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

A. Comply with ASTM C 840.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. 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.

D. Install 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.

E. Prefill open joints and damaged surface areas.

F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated, Mechanical, Electrical spaces, and Storage spaces.
   a. Primer and its application to surfaces are specified in Section 099000 "Painting General."
4. Level 5: All office, sales, and corridor areas.
   a. Primer and its application to surfaces are specified in Section 099000 "Painting General."

H. Protect adjacent surfaces from drywall compound and texture finishes and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

I. Remove and replace panels that are wet, moisture damaged, and mold damaged.

COT-092900

END OF SECTION 092900

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Suspended metal grid ceiling system.
2. Acoustical, metal and polycarbonate panels.
3. Perimeter trim.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for suspension systems, showing all components.

B. Shop Drawings: Show the following:
1. Layout of grid components and hanger spacing, including perimeter support wires.
2. Locations and methods of attachment of grid to walls. Clearance where grid is not attached to walls.
3. Connection of ends of main beams and cross tees.
4. Locations and details of compression struts and horizontal restraint wires or rigid bracing.
5. Bracing for changes in ceiling plane.
6. Locations and support details for light fixtures, diffusers, and other items within the ceiling system.

1.3 DELIVERY, STORAGE AND HANDLING

A. Deliver acoustical units in manufacturer's original unopened containers with brand name and type clearly marked.

B. Store under cover in dry, watertight conditions.

C. Prior to installation, store acoustical units for 24 hours minimum at same temperature and relative humidity as space where Work will be installed.

1.4 PROJECT CONDITIONS

A. Environmental Requirements: Maintain uniform temperature range of 60-85 degrees F, and humidity of no more than 70 percent relative humidity prior to, during, and after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide products by the following manufacturers as specified:
1. Armstrong World Industries Incorporated, Lancaster, PA (800) 448-1405.
2. Crane Composites, Channahon, IL (815) 467-8600.

B. Substitutions not allowed.

2.2 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics in Accordance with ASTM E 84 for Class A finish:
1. Flame Spread: Less than 25.
2. Smoke Density: Less than 50.

2.3 SUSPENSION SYSTEM

A. Provide suspension system specified herein for the corresponding ACT system as applicable as shown on the drawings. Provide suspension system compatible with acoustical panels selected.

B. ACT-1: Suspension System at Offices:
   1. Prelude Plus XL Aluminum 15/16 inch, Environmental Tee System by Armstrong.
   2. Size: 24 x 24.
   3. Color: White.

C. ACT-2: Suspension System at Laboratory and Prep Room. High strength pultruded FRP ceiling grid system:
   1. Kemlite Sanigrid II Ceiling Grid System, by Crane Composites.
   2. Size: 24 x 24.
   3. Color: White.

D. ACT-3: Suspension System at Room 204 SCADA: Clean Room ceiling grid system:
   1. Prelude 15/16 inch, Exposed Tee System by Armstrong.
   2. Size: 24 x 24.
   3. Color: White.

E. Hold-Down Clips: For installation in Room 204 SCADA.
   1. Standard Duty Clip: Manufacturer's standard retention clips to suit conditions specified.

F. Substitutions: Comply with the requirements of Section 016000.

2.4 ACOUSTICAL LAY-IN PANELS:

A. Provide acoustical panels specified herein for the corresponding ACT system as applicable as shown on the drawings.

B. ACT-1: ASTM E1264, Type IV, Form 2, Pattern E, Fire Class A, square lay-in, fine texture.
   1. Ultima 1900 with AirGuard Coating, by Armstrong.
   2. Size: 24 inch x 24 inch.
   3. Color: White.

C. ACT-2: ASTM E1264, Type XX, Form 2, Pattern C E, Fire Class A, square lay-in, medium texture.
   1. Ceramaguard, by Armstrong.
   2. Size: 24 inch x 24 inch.
   3. Color: White.

D. ACT-3: ACT at Room 204 SCADA - ASTM E1264, Type IV, Form 2, Pattern E .
   1. Clean Room VL Unperforated – Class 5 (Class 100), by Armstrong.
   2. Size: 24 inch x 24 inch.
   3. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and adjacent areas where products will be installed and verify that surfaces conform to product manufacturer's requirements for substrate conditions. Do not proceed until unsatisfactory conditions have been corrected.

B. Verify that layout of hangers will not interfere with other Work.

3.2 INSTALLATION – GENERAL

A. Interface with Other Work:
   1. Do not install acoustical ceilings until building is enclosed, heating is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
   2. Schedule installation of acoustic units after interior wet work is completed.
   3. Install after major above ceiling work is complete.
   4. Coordinate location of hangers with other Work.

B. Site Tolerances:
   1. Variation from Flat and Level Surface: 1/8 inch in 12 feet.

3.3 INSTALLATION - SUSPENSION SYSTEM

A. Install system in accordance with ASTM C 636 and manufacturer's published instructions.

B. Rigidly secure acoustical ceiling system including integral mechanical and electrical components with maximum deflection of 1/360.

C. If metal deck is not supplied with hanger tabs, coordinate installation of hanger clips during steel deck erection. Provide additional hangers and inserts as required.

D. Hang system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members. Where ducts or other equipment prevent regular spacing of hangers, reinforce nearest affected hangers and related carrying channels to span extra distance.

E. Locate system on room axis to a balanced grid design.

F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability. Do not eccentrically load system, or produce rotation of runners.

G. Install edge molding at intersection of ceiling and vertical surfaces using longest practical lengths. Miter corners. Provide edge moldings at junctions with other interruptions. Secure at 16 inches on center.

H. Rivet cross tee's at 4 feet on center to edge mold.

3.4 INSTALLATION - ACOUSTICAL PANELS

A. Fit acoustic units in place free from damaged edges or other defects. Install acoustic units level, in uniform plane, and free from twist, warp, and dents.

B. Install manufacturers standard duty hold-down clips to retain panels tight to grid system at each ceiling acoustical panel in Room 204 SCADA.

C. Apply manufacturer's recommended joint sealant to penetrations of ACT system in Room 204 SCADA.

3.5 FIELD QUALITY CONTROL

A. Field quality control shall be the responsibility of the Contractor. Except as specified as mandatory, field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements.

3.6 CLEANING

A. Clean exposed surfaces of panel ceilings including trim, edge moldings, and suspension system members.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Resilient base and accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following acceptable manufacturers:
   1. Mannington Commercial, Calhoun, GA (800) 241-2262.

B. Substitutions not allowed.

2.2 THERMOSET-RUBBER BASE

A. Thermoset Rubber Base: Thermoset vulcanized rubber, type TS.
   1. Product: Optimum Edge, by Mannington Commercial.
      a. Height: 4 inches.
      b. Thickness: 1/8 inch.
      c. Style: Coved.
      d. Lengths: Cut lengths 48 inches long or coils in manufacturer's standard length.
      e. Outside Corners: Job formed.
      f. Inside Corners: Job formed.
   2. RB-1: Color: Flax 918.
   3. RB-2: Color: Bark 904.

B. RB-3: Base to match existing in type, size, profile and color.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until they are the same temperature as the space where they are to be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
      a. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
      a. Miter or cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vinyl floor tile.
   2. Rubber floor tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and pattern specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by the following acceptable manufacturers:
   1. Mannington Commercial, Calhoun, GA (800) 241-2262.
   2. Schonox Inc., Florence, AL (256) 246-0345.

B. Substitutions not allowed.

2.2 VINYL FLOOR TILE

A. VT-1: Vinyl Floor Tile: Match existing in size, color, and composition.

2.3 RUBBER FLOOR TILE

A. RBF-1 Rubber Floor Tile: ASTM F 1344, thermoset rubber floor tile.
   1. Product: Colorscape, by Mannington Commercial.
      a. Size: 18-1/8 inch x 18-1/8 inch.
      b. Thickness: 1/8 inch.
      c. Color: Flax 918.
      d. Profile: Square.
      e. Installation: Monolithic.

2.4 SUBFLOOR REPAIR MATERIALS

A. Subfloor Filler: Provide one of the following:
   1. Cementitous Based Underlayment Subfloor Filler:
      a. Ardex SD-F Feather Finish, by Ardex Engineered Cements, Contact: Ben Mack (724) 203-5060.
      b. Levelayer I, by Dayton Superior.
      c. No. 547 UniPro Universal Underlayment by W.W. Henry, Contact: Ben Mack (724) 203-5060.
   2. Epoxy Subfloor Filler: MasterSeal CR 190, two-part 100% solids flexible epoxy joint filler, by BASF Building Systems (800) 433-9517.

B. Fast Set Portland Cement/latex Based Patch: Provide the following product:
   1. Kwik Patch by Azrock.
   2. If Kwik Patch is unavailable, provide one of the following products:
      a. Plani-Patch by Mapei Corp., Deerfield Beach, FL (800) 426-2734.
      b. Featherfinish by Ardex Engineered Cements, Aliquippa, PA (888) 512-7339.

2.5 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

C. Adhesive at Floor Drain: Schonox PU 900, by Schonox.

D. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.
   4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
   1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.2 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

G. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.

END OF SECTION 096519

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes modular carpet tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For carpet tile installation, plans showing the following:
   1. Carpet tile type, color, and dye lot.
   2. Type of subfloor.
   3. Type of installation.
   4. Pattern of installation.
   5. Pattern type, location, and direction.
   6. Pile direction.
   7. Type, color, and location of edge, transition, and other accessory strips.
   8. Transition details to other flooring materials.

C. Samples: For each exposed product and for each color and texture required.

1.3 IINFORMATIONAL SUBMITTALS

A. Product test reports.

B. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

A. Subject to compliance with requirements, provide products by the following acceptable manufacturer:

1. Shaw Industries Group, Dalton, GA (800) 257-7429.

B. Substitutions not allowed.

2.2 CARPET TILE

A. CPT-1 Carpet Tile: Multi-level pattern loop.
   1. Product: Kinetic Tile, by Shaw.
      a. Style No.: 59359.
      b. Thickness: 0.268 inches.
      c. Size: 24 inches x 24 inches.
      d. Color: Silver Lining 58530.
      e. Installation: 1/3 brick ashlar.

B. Substitutions not allowed.

2.3 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Concrete Slabs:
   1. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
      a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
      b. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
      c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

3.2 PREPARATION

A. General: Comply with CRI's "CRI Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns indicated on Drawings.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

J. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 099000 – PAINTING AND COATING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Field applied paints and finishes for interior surfaces.

B. Related Sections:
   1. Section 079200 – Joint Sealants: Joint sealants at substrate.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent references. Publications are referenced within the text by the basic designation only.

B. Steel Structures Painting Council (SSPC):
   1. SSPC-SP 1 – Solvent Cleaning.
   2. SSPC-SP 7 – Brush-Off Blast Cleaning.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. VOC Content: Provide paint and coating materials that conform to Federal, State, and Local restrictions for Volatile Organic Compounds (VOC) content.
   2. Toxicity/EQ: Comply with Federal, State, and Local toxicity and environmental quality regulations and with Federal requirements on content of lead, mercury, and heavy metals. Do not use solvents in paint products that contribute to air pollution.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, store, and protect products in compliance with the requirements of Section 016000.

B. Delivery of paint materials shall be in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and/or reducing. Notify Supplier when delivered products do not conform to these requirements.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Apply paint finishes only when moisture content of surfaces is within manufacturer's acceptable ranges for type of finish being applied.

B. Minimum surface temperatures or ambient air temperature shall be as follows for the specified coatings unless otherwise specifically stated by the manufacturer for the specific coating:
   1. Alkyd and interior and exterior latex finishes: 50 degrees F.
   2. Varnish and transparent finishes: 65 degrees F.
   3. All coatings: 5 degrees F above dew point.

C. Provide continuous ventilation and heating facilities to maintain temperatures above the manufacturer's stated minimum surface and air temperature for 24 hours prior to, during, and 48 hours after application of interior finishes.

D. Do not apply paint in areas where dust is being generated.

E. Provide lighting level in areas being painted of 80 foot candles measured mid-height at substrate surface.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to requirements, provide products by the following manufacturer:
   1. Sherwin-Williams, Cleveland, OH.
      a. Contact: Stephen Sanders, Commercial Sales Representative. Phone: (918) 370-7209. Email: swrep7969@sherwin.com.
      b. Contact: Michael Bilyard, Protective Coatings Representative (lab and prep room coatings). Phone (918) 808-8234.
   2. Substitutions not allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
   2. Remove all sealants, flashing, and loose or damaged brick/mortar from parapet walls and joints.

B. Aluminum Substrates: Remove all oil, grease, dirt, oxide and other foreign material by cleaning per SSPC-SP1, Solvent Cleaning.

C. Drywall, Interior and Exterior:
   1. Surface must be clean and dry.
   2. All nail heads must be set and spackled.
   3. Joints must be taped and covered with a joint compound.
   4. Spackled nail heads and taped joints must be sanded smooth, and all dust removed prior to painting.
   5. Exterior surfaces must be spackled with exterior grade compounds.

D. Galvanized Metal:
   1. Allow to weather a minimum of six (6) months prior to coating.
   2. Clean per SSPC-SP1 using detergent and water, or a degreasing cleaner; then prime as required.
   3. When weather is not possible, or the surface has been treated with chromates or silicates, first solvent clean per SSPC-SP1 and apply a test area, priming as required. Allow the coating to dry at least one (1) week before testing. If adhesion is poor, brush blast per SSPC-SP7 as required to remove these treatments.

E. Wood, Interior:
   1. Store all finishing lumber and flooring in dry, warm rooms to prevent absorption of moisture, shrinkage, and roughening of the wood.
   2. Sand smooth all surfaces, with the grain, never across it.
   3. Correct surface blemishes and clean surface of dust before coating.

3.3 APPLICATION

A. 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.

B. Plaster: Prime all patched areas. Add a texturing additive in the paint or use a texturing coat in under the paint to match original texture.

C. Previously Painted Surfaces at Lab and Prep:
   1. If in sound condition, clean the surface of all foreign material. Smooth, hard or glossy coatings and surfaces should be dulled by abrading the surface. Apply a test are, allowing paint to dry one week before testing adhesion. If adhesion is poor, or if this product attacks the previous finish, removal of the previous coating may be necessary. If paint is peeling or badly weathered, clean surface to sound substrate and treat as a new surface.

3.4 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Where exposed piping, conduit, and electrical equipment are to be painted, paint color and texture shall match adjacent surfaces.

B. Paint both sides and edges of plywood backboards for electrical equipment prior to installation.

3.5 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.

3.6 PAINTING SCHEDULE

INTERIOR PAINTING SCHEDULE							
Surface	**Sheen**	**1st Coat**	**DFT (mils) (per coat)**	**VOC (g/l)**	**2nd and 3rd Coats**	**DFT (mils) (per coat)**	**VOC (g/l)**
Gypsum Board	Low	ProMar 200 Zero VOC Interior Latex Primer B28W02600, by Sherwin-Williams	1.0	<50	2 Coats: ProMar 200 Interior Latex Low Sheen B20W01251, by Sherwin-Williams	1.5	94
Gypsum Board (Lab & Prep Rm)	Semi-Gloss	ProMar 200 Zero VOC Primer B28W2600	1.0	0	Macropoxy 646 Fast Cure Epoxy	5.0 – 10.0	<250
Painted Wood-work	Semi-Gloss	Multi-Purpose Interior/Exterior Latex Primer B51W00450, by Sherwin-Williams	1.4	<50	2 Coats: SOLO Interior/Exterior 100% Acrylic, Semi-Gloss A76W00051, by Sherwin-Williams	1.5	<50
Painted Ferrous Metal/Non Ferrous Metal	Semi-Gloss	ProIndustrial Pro-Cryl Universal Acrylic Primer B66W00310, by Sherwin-Williams	2.0 – 4.0	96	2 Coats: ProIndustrial DTM Acrylic Semi-Gloss B66W01151, by Sherwin-Williams	2.5 – 4.0	<50

END OF SECTION 099000

SECTION 123216.10 – INDUSTRIAL LAMINATE CLAD CASEWORK

PART 1 – GENERAL

1.01 SECTION INCLUDES
- A. Fixed modular laminate clad casework and components.
- B. Countertops.

1.02 RELATED SECTIONS
- A. Divisions 5 and 6: Behind The Wall Blocking and Studs
- B. Division 9: Base Molding
- C. Division 11: Appliances
- D. Divison 15: Plumbing
- E. Division 16: Electrical Service Fixtures and Connections

1.03 DEFINITIONS
- A. Identification of casework components and related products by surface visibility.
  1. Open Interiors: Any open storage unit without solid door or drawer fronts, units with full glass insert doors and/or acrylic doors, and units with sliding solid doors.
  2. Closed Interiors: Any closed storage unit behind solid door or drawer fronts.
  3. Exposed Ends: Any storage unit exterior side surface that is visible after installation.
  4. Other Exposed Surfaces: Faces of doors and drawers when closed, and tops of cabinets less than 72" above furnished floor.
  5. Semi-Exposed Surfaces: Interior surfaces which are visible, bottoms of wall cabinets and tops of cabinets 72" or more above finished floor.
  6. Concealed Surfaces: Any surface not visible after installation.

1.04 QUALITY ASSURANCE
- A. Manufacturer: Minimum of 5 years experience in providing manufactured casework systems for similar types of projects, produce evidence of financial stability, bonding capacity, and adequate facilities and personnel required to perform on this project.
- B. Manufacturer: Provide products certified as meeting or exceeding ANSI A161.1-2000 testing standards.
- C. Manufacturer: Provide products meeting or exceeding SEFA 8 PL-2010 Recommended Practices for Plastic Laminate Laboratory Grade Furniture, Casework, Shelving and Tables, as established in the Scientific Equipment & Furniture Association (SEFA) 2010 Desk Reference, 4th Edition.
- D. Quality Standard: Unless otherwise indicated, comply with AWI's Architectural Woodwork Quality Standards for grades of interior architectural woodwork, construction, finishes and other requirements.
  1. Provide affirmation letter from AWI that manufacturer is duly certified for premium grade from the AWI Quality Certification Program for sections 400B (Laminate Cabinets), 400C (Countertops), and 1600 (Modular Cabinets).
  2. Provide labels indicating that manufactured casework meets AWI standards.

1.05 SUBMITTALS
- A. Comply with Division 1, unless otherwise indicated.
- B. Product Data: Manufacturer's catalog with specifications and construction details.
- C. Shop Drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.
  1. Include section drawings of typical and special casework, work surfaces and accessories.
  2. Indicate locations of plumbing and electrical service field connection by others.

1.06 PRODUCT HANDLING

A. Deliver completed laminate clad casework, countertops, and related products only after wet operations in building are completed, store in ventilated place, protected from the weather, with relative humidity range of 25 percent to 55 percent.

B. Protect finished surfaces from soiling and damage during handling and installation with a protective covering.

1.07 JOB CONDITIONS

A. Environmental Requirements: Do not install casework until permanent HVAC systems are operating and temperature and humidity have been stabilized for at least 1 week.

1. Manufacturer/Supplier shall advise Contractor of temperature and humidity requirements for architectural casework installation areas.

2. After installation, control temperature and humidity to maintain relative humidity between 25 percent and 55 percent.

B. Conditions: Do not install casework until interior concrete work, masonry, plastering and other wet operations are complete.

1.08 WARRANTY

A. All materials and workmanship covered by this section will carry a five (5) year warranty from date of acceptance.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Manufacturer:

1. Kewaunee Scientific Corporation.

a. Drawings and specifications are based on Kewaunee Scientific SpeKtrum Series laminate products for fixed modular, flexible rail mounted, and mobile casework and accessories.

b. Other manufacturers shall comply with the minimum levels of material and detailing indicated on the drawings or as specified.

2.02 MATERIALS

A. Core Materials:

1. Particleboard: 40-50 pound density particleboard according to ANSI A208.1-2009, grade M-2 specifications.

2. MR Moisture Resistant Particleboard: 40-50 pound density particleboard according to ANSI A208.1-2009, grade M-2-MR10 moisture resistant specifications.

3. Medium Density Fiberboard 6mm (1/4") thick: Average 54-pound density MDF according to ANSI A208.2-2009 grade 130 specifications.

B. Decorative Laminates: GREENGUARD Indoor Air Quality Certified

1. High-pressure decorative laminate VGS (0.70mm [0.028"]), NEMA Test LD 3-2005.

2. High-pressure decorative laminate HGS (1.22mm [0.048"]), NEMA Test LD 3-2005.

3. High-pressure decorative laminate HGP (1.00mm [0.039"]), NEMA Test LD 3-2005.

4. High-pressure cabinet liner CLS (0.50mm [0.020"]), NEMA Test LD 3-2005.

5. Chemical-Resistant decorative laminate, NEMA Test LD 3-2005

6. High-pressure backer, NEMA Test LD 3-2005.

7. Thermally fused melamine TFM laminate, NEMA Test LD 3-2005.

C. Laminate Color Selection: Maximum 1 color per unit face and 5 colors per project. (See Color Selection in section 3.05).

D. Edging Materials:

1. 1mm PVC banding, machine applied.

2. 3mm PVC banding, machine applied and machine profiled to 3 mm radius.

E. Glass:

1. Wall unit full sliding glass doors: 6mm (1/4") thick laminated safety glass.

2. Glass insert doors, hinged or sliding wall cabinets: 3mm (1/8") thick tempered glass.
3. Glass insert doors, hinged or sliding tall or base cabinets. 3mm (1/8") thick tempered glass.
4. Sliding doors mounted in aluminum track.
5. Trim glass inserts: Extruded rigid PVC channel and self-locking insert retainer strip.

2.03 SPECIALTY ITEMS

A. Support Members:
1. Countertop support brackets: Epoxy powder coated, 11ga steel with integral cleat mount opening and wire management opening.
2. Undercounter support frames: Epoxy powder coated.
3. Legs: Epoxy powder coated.

B. Computer Keyboard Tray:
1. Non-articulating, undercounter mount with positive stop drawer slides.

2.04 CABINET HARDWARE

A. Hinges:
1. Five knuckle, epoxy coated, institutional grade, 70mm (2.75") overlay type with hospital tip. 2.4mm (0.095") thick. ANSI-BHMA standard A156.9, Grade 1.
a. Doors 1219mm (48") and over in height have 3 hinges per door.

B. Pulls
1. Door and drawer front pulls are metal wire with epoxy coated finish, 96mm spacing on fasteners. Pull design is compatible with the Americans with Disability Act (ADA).

C. Drawer Slides:
1. Regular, kneespace, and pencil: Full extension 100-pound load rated cold rolled steel, side mounted with steel ballbearings. Featuring an easy to operate disconnect finger release system.
2. File: Full extension 150-pound load rated cold rolled steel, side mounted with steel ballbearings. Featuring an easy lift-off drawer rail disconnect.

D. Adjustable Shelf Supports:
1. Injection molded transparent polycarbonate friction fit into cabinet end panels and vertical dividers, adjustable on 32mm centers. Each shelf support has 2 integral support pins, 5mm diameter, to interface pre-drilled holes, and to prevent accidental rotation of support. The support automatically adapts to 19mm (3/4") or 25mm (1") thick shelving and provides non-tip feature for shelving. Supports may be field fixed if desired. Structural load to 1200 pounds (300 pounds per support) without failure.

2.05 FABRICATION:

A. Fabricate casework, countertops and related products to dimensions, profiles, and details shown.

B. All casework panel components must be precisely cut to size and squareness to ensure strict dimensional quality and structural integrity in the final fabricated product.

C. Cabinet Body Construction:
1. Tops and bottoms are made of particleboard core and glued and doweled to cabinet sides and internal cabinet components such as fixed horizontals, rails and verticals. Minimum 6 dowels each joint for 24" deep cabinets and a minimum of 4 dowels each joint for 12" deep cabinets.
2. Cabinet backs: 6mm (1/4") thick medium density fiberboard panel fully captured by the cabinet top, bottom and side panels. Finish to match cabinet interior. Mounting stretchers that are 19mm (3/4") thick particleboard rails are placed behind the back panel for attachment to the wall, and are doweled to the sides

utilizing 10mm hardwood fluted dowels. An extra mounting stretcher will be included on all cabinets taller than 1422mm (56"). Utilize hot melt glue to further secure back and increase overall strength.

a. Cabinets with a finished back: 19mm (3/4") thick particleboard with the exterior surface finished in VGS laminate as selected.

3. Fixed base and tall units have an individual factory-applied base, constructed of 19mm (3/4") thick plywood. Base is 102mm (4") high unless otherwise indicated on the drawings.
4. Base units, except sink base units: Full sub-top. Sink base units are provided with open top and a stretcher at the front, attached to the sides. Back to be split removable access panel.
5. Side panels and vertical dividers shall receive adjustable shelf hardware at 32mm line boring centers. Mount door hinges, drawer slides and pull-out shelves in the line boring for consistent alignment.
6. Exposed and semi exposed edges.
   a. Edging: 3mm PVC machine applied and machine profiled to 3mm (1/8") radius.
7. Adjustable Shelves in Cabinets: 19mm (3/4") particleboard core available in lengths of up to 36" to meet AWI specifications.
   c. Edge: 3mm PVC on Front Edge, 1mm PVC on Side and Back Edges.
8. Interior finish, units with open Interiors:
   a. Top, bottom, back, sides, horizontal and vertical members, and adjustable shelving faces with high pressure decorative VGS laminate.
9. Interior finish, units with closed Interiors:
   a. Top, bottom, back, sides, horizontal and vertical members, and adjustable shelving faces with TFM Thermally Fused Melamine laminate.
10. Exposed ends:
    1. Faced with high-pressure decorative VGS laminate.
11. Wall unit bottom:
    a. Faced with thermally fused melamine laminate.
12. Balanced construction of all laminated panels is mandatory. Unfinished core stock surfaces, even on concealed surfaces (excluding edges), are not permitted.

D. Drawers:
1. Sides, back and sub front: Minimum 12mm (1/2") thick particleboard, laminated with thermally fused melamine doweled and glued into sides. Top edge banded with 1mm PVC.
2. Drawer bottom: Minimum 12mm (1/2") thick particleboard laminated with thermally fused melamine, assembled into a machined groove on all four sides of the box and secured with hot melt glue.

E. Door/Drawer Fronts:
1. Core: 19mm (3/4") thick particleboard except at sink units which are 19mm (3/4") thick moisture resistant particleboard.
2. Exterior faced with high-pressure decorative VGS laminate, balanced with high-pressure cabinet liner.
3. Edges: 3mm PVC, machine applied, external edges and outside corners machine profiled to 3mm (1/8") radius.
4. Provide double doors when the opening is nominally in excess of 610mm (24") wide.

Choose one:

F. Miscellaneous Shelving (not in Cabinets):
1. Core material: 25mm (1") thick particleboard.
2. High-pressure decorative VGS laminate on both faces.
3. Edges: 3mm PVC, external edges and outside corners machine profiled to 3mm (1/8") radius.

2.06 WORKSURFACES

A. MATERIALS

1. Epoxy Resin Tops (Kemresin):
   Epoxy Resin tops shall consist of modified epoxy resin that has been especially compounded and cured to provide the optimum physical and chemical resistance properties required of a heavy-duty laboratory table top. Tops and curbs shall be a uniform mixture throughout their full thickness, and shall not depend upon a surface coating that is readily removed by chemical and/or physical abuse. Tops and curbs shall be non-glaring. Tops shall be 1" thick, exposed edges beveled top and bottom, and drip grooves provided on the underside at all exposed edges. 4" high curbs at the backs and ends of tops shall be 1" thick and bonded to the deck to form a square watertight joint. Sink cutouts shall be smooth and uniform without saw marks with the top edge beveled. The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness. Corners of sink cutouts shall be radiused not less than 3/4". Where called out on plans, provide marine edge on front edge and side

B. WORK TOP PERFORMANCE REQUIREMENTS:
   1. Molded Epoxy Resin:
      a. Physical Properties:

Flexural Strength (A.S.T.M. Method D790-90) =	15,000 PSI
Compressive Strength (A.S.T.M. MethodD695-90) =	30,000 PSI
Hardness, Rockwell E (A.S.T.M. Method D785-89) =	100
Water Absorption (A.S.T.M. Method D570-81)% by weight, 24 Hours =	0.04
% by weight, 7 Days =	0.05
% by weight, 2 Hour Boil =	0.04
Specific Gravity =	1.97
Tensile Strength =	8,500 PSI

      b. Performance Test Results (Heat Resistance):
         A high form porcelain crucible, size 0, 15 ml capacity, shall be heated over a Bunsen burner until the crucible bottom attains an incipient red heat. Immediately, the hot crucible shall be transferred to the top surface and allowed to cool to room temperature. Upon removal of the cooled crucible, there shall be no blisters, cracks or any breakdown of the top surface whatsoever.

      c. Performance Test Results (Chemical Resistance):
         Tops shall resist chemical attacks from normally used laboratory reagents. Weight change of top samples submerged in the reagents* listed in the next paragraph for a period of seven (7) days shall be less than one-tenth of one percent, except that the weight change for those reagents marked with ** shall be less than one percent. (Tests shall be performed in accordance with A.S.T.M. Method D543-67 at 77o F.).

         *Where concentrations are indicated, percentages are by weight.

Acetic Acid, Glacial Iso-Octane	
Acetic Acid, 5%	Kerosene
Acetone	Methyl Alcohol
Ammonium Hydroxide, 28%	Mineral Oil
Ammonium Hydroxide, 10%	Methyl Ethyl Ketone
Aniline Oil	Nitric Acid, 70%**
Benzene	Nitric Acid, 40%
Carbon Tetrachloride	Nitric Acid, 10%
Chromic Acid, 40%**	Oleic Acid
Citric Acid, 10%	Olive Oil
Cottonseed Oil	Phenol, 5%
Dichromate Cleaning Solution**	Soap Solution, 1%
Diethyl Ether	Sodium Carbonate, 20%
Dimethyl Formamide	Sodium Carbonate, 2%
Distilled Water	Sodium Chloride, 10%
Detergent Solution, 1/4%	Sodium Hydroxide, 50%
Ethyl Acetate	Sodium Hydroxide, 10%
Ethyl Alcohol, 95%	Sodium Hydroxide, 1%

Ethyl Alcohol, 50%	Sodium Hypochlorite,5%
Ethylene Dichloride	Sulfuric Acid, 85%
Heptane	Sulfuric Acid, 30%
Hydrochloric Acid, 37%	Sulfuric Acid, 3%
Hydrochloric Acid, 10%	Toluene
Hydrogen Peroxide, 28%	Transformer Oil
Hydrogen Peroxide, 3%	Turpentine

NOTE: Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

d. Performance Test Results (Chemical Spot Tests - 24 Hours):
Chemical spot tests shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.

Ratings:

A = No effect or slight change in gloss.
B = Slight change in color or marked loss of gloss.
C = Slight surface etching or severe staining.
D = Swelling, pitting, or severe etching.

Reagents*	Rating
Acetic Acid, 98%	A
Acetone**	A
Ammonium Hydroxide, 28%	A
Carbon Tetrachloride**	A
Chloroform**	A
Chromic Acid, 60%	C
Chromic Acid, 40%	C
Dichromate Cleaning Solution***	C
Dimethyl Formamide	A
Ethyl Acetate**	A
Ethyl Alcohol**	A
Formaldehyde, 37%	A
Formic Acid, 90%	A
Hydrochloric Acid, 37%	A
Hydrofluoric Acid, 48%	C
Hydrogen Peroxide, 28%	A
Methanol**	A
Methylethyl Ketone**	A
Nitric Acid, 70%	B
Phenol, 85%	A
Phosphoric Acid, 85%	A
Sodium Carbonate, 20%	A
Sodium Hydroxide, 40%	A
Sodium Hydroxide, 10%	A
Sodium Hypochlorite, 5%	A
Sulfuric Acid, 96%	D

Sulfuric Acid, 85%	A
Toluene**	A
Wrights Blood Stain	A
Xylene**	A

* Where concentrations are indicated, percentages are by weight.
** Indicates these solvents tested with cotton and jar method.
*** Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

2.07 EPOXY RESIN SINKS

A. Molded Epoxy Resin Sinks (KEMRESIN):
Sinks shall be molded of modified epoxy resin, carefully compounded with selected materials to provide maximum physical and chemical properties. Sinks shall be non-glaring with all inside corners coved and the bottom pitched to the drain outlet. Sinks shall possess a high resistance to mechanical and thermal shock.

2.08 SERVICE FITTINGS AND ACCESSORIES

A. MATERIALS:

1. Laboratory Service Fittings:
Service fittings shall be laboratory grade, and water faucets and valve bodies shall be cast red brass alloy or bronze forgings, with a minimum content of 85%. All fittings shall be chromium plated unless specified otherwise.

2. Service Indexes:
Fittings shall be identified with service indexes in the following color coding:

Hot Water.....Red
Cold Water.....Dark Green
Gas.....Dark Blue
Air.....Orange
Vacuum.....Yellow
Distilled Water..White
Steam.....Black
Nitrogen.....Brown
Oxygen.....Light Green
Hydrogen.....Pink
Special Gases..Light Blue

B. CONSTRUCTION:

1. Water Fittings:
Water fittings shall be provided with a renewable unit containing all operating parts which are subject to wear. The renewable unit shall contain an integral volume control device and all faucets shall be capable of being readily converted from compression to self-closing, without disturbing the faucet body proper. Four (4) arm forged brass handles shall contain plastic screw-on type colored service index buttons.

2. Distilled Water Fittings:
Distilled water fittings shall be chromium plated cast bronze with the interior PVC lined. Water Saver Model L7833SC

3. Needle Valve Hose Cocks:
Needle type valves shall have a stainless steel replaceable floating cone, precision finished and self-centering. Cone locates against a stainless steel seat, easily removable and replaced with a socket wrench. Valve shall have "TEFLON" impregnated packing and designed so unit can be repacked while under pressure.

4. Gooseneck Type Outlets:
   Gooseneck outlets shall have a separate brazed coupling to provide a full thread attachment of anti-splash, serrated tip or filter pump fittings.

5. Remote Control Valves:
   All valves for remote control use shall be as previously specified, but shall be complete with aluminum extension rods, escutcheon plates, brass forged handles and screw-on type colored service index button.

6. Tank Nipples:
   Tank nipples shall be provided with locking nut and washer for all fixtures where fittings are anchored to equipment.

7. Vacuum Breakers:
   Vacuum breakers where required shall be "Nidel" or "Watts" unless otherwise specified or identified to be an integral part of the water fixture assembly.

8. Aerator Outlets:
   Aerator type outlets shall be furnished for all gooseneck water faucets not furnished with serrated hose connectors.

9. Waste Lines:
   Waste lines shall be furnished by other trades.

10. Traps:
    Traps shall be furnished by other trades.

11. Electrical Fittings:
    Electrical fittings shall contain 20 Amp., 125 Volt AC, 3-wire polarized grounded receptacles, unless otherwise specified. Pedestal and line-type boxes shall be of aluminum, metallic finish with stainless steel flush plates. Receptacle boxes shall be of plated steel. All electrical or conduit fittings called for or to be furnished under these specifications shall meet the requirements of the National Electrical Code.

C. PERFORMANCE:

1. Maximum Line Pressures:
   Laboratory Ball Valves (Gas and Air) ..... 75 PSI
   Needle Point Cocks (Gas and Air)..... 65 PSI
   Vacuum..... 28.5" Mercury
   Hot and Cold Water..... 80 PSI
   Steam ..... 30 PSI

2. Sepia Bronze Finish Performance:
   Finish shall show no rupture, other than a slight discoloration or possible softening when subjected to the following fumes for approximately six (6) days: Plastic coated fittings shall be suspended in a container, 6 cu. ft. capacity 12" above open beakers, each containing 199 cc. of 70% Nitric Acid, 94% Sulphuric Acid, 37-38% Hydrochloric Acid, respectively. Finish shall also withstand direct contact of reagents dropped from a burette at a rate of 60 drops/min. for a period of 10 minutes. Chemicals are shown below:
   a. Concentrated Hydrochloric Acid 37-38%*
   b. Concentrated Nitric Acid 70%*
   c. Concentrated Sulphuric Acid 94%
   d. Glacial Acetic Acid 99.5%*
   e. Ethyl and Other Alcohols
   f. Toulene and Other Hydrocarbons
   g. Carbon - Tetrachloride
   h. Mineral Oil

   *Percentages are by weight.

PART 3- EXECUTION

3.01 INSPECTION:

A. The casework contractor must examine the job site and the conditions under which the work under this section is to be performed, and notify the building owner in writing of unsatisfactory conditions. Do not proceed with work under this Section until satisfactory conditions have been corrected in a manner acceptable to the installer.

3.02 PREPARATION:

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

3.03 INSTALLATION:

A. Erect casework, plumb, level, true and straight with no distortions. Shim as required. Where laminate clad casework abuts other finished work, scribe and cut to accurate fit.

B. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind.

C. Repair minor damage per plastic laminate manufacturer's recommendations.

3.04 CLEANING:

A. Remove and dispose of all packing materials and related construction debris.

B. Clean cabinets inside and out. Wipe off fingerprints, pencil marks, and surface soil etc., in preparation for final cleaning by the building owner.

3.05 COLOR SELECTION:

A. Laminate Color Selection:

1. Laminates will be chosen from the full range of standard Wilsonart and Formica stock color charts or equivalent products.
2. Thermally fused melamine laminate matched to White color.

B. Hardware Color Selection:

1. Hinge: Select from your choice of brushed stainless steel or epoxy powder coating stock colors matched to White, Beige, Gray, Black and Satin Chrome.
2. Pulls: Select from your choice of brushed chrome finish or epoxy powder coating stock colors matched to White, Beige, Gray, Black and Chrome.
3. Miscellaneous Hardware (support brackets, table frames, etc.): Select from your choice of epoxy powder coating stock colors matched to White, Beige, Gray, Black and Chrome.

C. PVC Edge Banding Color Selection:
   1. 1mm and 3mm PVC: Select from the full range of pattern, woodgrain and solid colors matched to Wilsonart, Formica, or other equivalent laminates.

END OF SECTION 123216.10

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Sprinklers.

1.2 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.3 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 5 psig, including losses through water-service piping, valves, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications:
   a. Data Room, Conference Room, and Office Areas: Light Hazard

3. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.

4. Maximum Protection Area per Sprinkler:
   a. Data Room, Conference Room, and Office Areas: 225 sq. ft.
   b. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm for 30 minutes.

1.4 SUBMITTALS

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

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified NICET level III designer responsible for their preparation.

D. Qualification Data: For qualified Installer.

E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

G. Field quality-control reports.

H. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume design responsibility. Base calculations on results of fire-hydrant flow test.

   a. Designing Responsibility: Preparation of working plans, calculations, and field test reports by a qualified NICET Level III designer.

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. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized and Black Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Thinwall Galvanized and Black Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

C. Galvanized and Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Anvil International, Inc.
   b. Corcoran Piping System Co.
   c. National Fittings, Inc.
   d. Shurjoint Piping Products.
   e. Tyco Fire & Building Products LP.
   f. Victaulic Company.

2. Pressure Rating: 175 psig minimum.

3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

5. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Victaulic Company.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

   1. Class 125, Cast-Iron Flat-Face Flanges: Full-face gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      a. Anvil International, Inc.
      b. National Fittings, Inc.
      c. Shurjoint Piping Products.
      d. Tyco Fire & Building Products LP.
      e. Victaulic Company.

   2. Standard: UL 213.
   3. Pressure Rating: 175 psig minimum
   4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
   5. Type: Mechanical-T and -cross fittings.
   6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
   7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
   8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flexible, Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Fivalco Inc.
   b. FlexHead Industries, Inc.
   c. Gateway Tubing, Inc.

2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175 psig minimum.
5. Size: Same as connected piping, for sprinkler.

2.5 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Tyco Fire & Building Products LP.
4. Victaulic Company.
5. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inchorifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Escutcheon: Match existing.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4

and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Fill sprinkler system piping with water.

N. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.2 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of wood plank ceiling panels.

B. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.4 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.7 PIPING SCHEDULE

A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

B. Wet-pipe sprinkler system, NPS 1 1/2and smaller,shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Standard-weight, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 to NPS 6, shall be one of the following:
1. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
2. Thinwall black-steel pipe with plain ends; welding fittings; and welded joints.

3.8 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Special Applications: Quick-response sprinklers where indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Brass, with white flat escutcheon.
2. Upright Pendent and Sidewall Sprinklers: Chrome plated.

END OF SECTION 211313

SECTION 212200 - CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 APPLICABLE STANDARDS AND PUBLICATIONS

A. The design, installation, testing and maintenance of the Clean Agent Extinguishing System shall be in accordance with the applicable requirements set forth in the latest edition of the following codes, standards, and third party approval agencies:

1. NFPA 2001: Standard on Clean Agent Fire Extinguishing Systems
2. NFPA 70: National Electrical Code
3. NFPA 72: National Fire Alarm and Signaling Code
4. Factory Mutual (FM)
5. Underwriters Laboratories (UL)
6. Requirements of the local Authority Having Jurisdiction (AHJ)

1.3 SUMMARY

A. Section Includes:

1. Piping and piping specialties.
2. Extinguishing-agent containers.
3. Extinguishing agent.
4. Detection and alarm devices.
5. Releasing control panel.
6. Accessories.
7. Connection devices for and wiring between system components.
8. Connection devices for power and integration into building's fire-alarm system.

B. Section Excludes:

1. Power supply (120/240 VAC) to system control panel.
2. Interface (conduit and wiring) to HVAC units, dampers, electric power supplies, relays, or shunt-trip breakers.
3. Interface (conduit and wiring) to local/remote fire alarm system
4. Connection to listed central station fire alarm system.
5. Room sealing, other than penetrations made by the suppression system contractor during system installation. Suppression system contractor shall

coordinate room sealing requirements with project's General contractor and all sub-contractors.

1.4 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. ATS: Acceptance Testing Specifications.

C. EPO: Emergency Power Off.

1.5 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that clean agents comply.

C. Shop Drawings:

1. Prepared by persons with the following qualifications:
   a. Trained and certified by the manufacturer of the Clean Agent Suppression system.
   b. NICET certified Fire-Alarm Technician, Level III minimum.
2. Comply with recommendations in the "Working Plans" Section of the "System Design" Chapter in NFPA 2001.
3. Comply with the recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
4. Include plans, elevations, sections, details, and attachments to other work.
5. Include design calculations: Enclosure volume, agent quantity, backup battery, voltage drop, detector spacing, etc.
6. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
7. Include plans to indicate mounting location of field devices, including size and routing of cable and conduits.
8. Submittals shall be signed and sealed by a qualified professional engineer prior to submitting them to the Authority Having Jurisdiction.
9. Submittals shall be approved by the Authority Having Jurisdiction prior to submitting them to Architect.

D. Delegated-Design Submittal: For clean-agent fire-extinguishing system signed and sealed by the qualified professional engineer.

1. Indicate compliance with performance requirements and design criteria, including analysis data.
2. Include design calculations for selecting the spacing and sensitivity of detection devices, complying with NFPA 72.
3. Include design calculations for weight, volume, and concentration of extinguishing agent required for each hazard area.
4. Include design calculations for enclosure pressure relief/venting as required to avoid structural damage to the hazard enclosure, equipment, or building.
5. Indicate the Following on Reflected Ceiling Plans:
    a. Ceiling penetrations and ceiling-mounted items.
    b. Extinguishing-agent containers if mounted above floor, piping and discharge nozzles, detectors, and accessories.
    c. Method of attaching hangers to building structure.
    d. Other ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
6. Indicate the Following on Occupied Work Area Plans:
    a. Controls and alarms.
    b. Extinguishing-agent containers, piping and discharge nozzles if mounted in space, detectors, and accessories.
    c. Equipment and furnishings.
7. Indicate the Following on Access Floor Space Plans:
    a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
    b. Method of supporting piping.
8. Indicate the Following on Ceiling Plans:
    a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
    b. Method of supporting piping.
    c. Other equipment located in the ceiling space that is being protected including sprinkler piping, HVAC equipment, raceways, or conduit.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Domestic water piping.
2. Items Penetrating Finished Ceiling Include the Following:
    a. Lighting fixtures.
    b. Air outlets and inlets.

B. Permit Approved Drawings: Working plans, prepared according to NFPA 2001, that have been approved by authorities having jurisdiction. Include design calculations.

C. Seismic Qualification Certificates: For extinguishing-agent containers and control panels from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

E. Installer Qualifications:

1. Authorized distributor of the system manufacturer. Shall maintain an inventory of replacement parts.
2. Trained by the system manufacturer to design, install, test, and maintain the clean agent extinguishing system.
3. Provide proof of emergency service available on a twenty-four hour, seven-days-a-week basis.
4. Maintain or have access to a recharging station capable of recharging the largest suppression system within 72 hours after a discharge.
5. Minimum five (5) years' experience in the design, installation, and testing of clean-agent fire extinguishing systems. A list of systems of similar nature and scope shall be provided upon request.
6. Shall employ a NICET Level II certified special hazard designer, who will be responsible for this project.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For special agent system to include in emergency, operation, and maintenance manuals.

B. Deliver copies to Authorities Having Jurisdiction and include the following:
1. Comply with the "Records" Section of the "Inspections, Testing and Maintenance" Chapter of NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at the control panel.

7. Copy of NFPA 25.

C. As-built Drawings: Indicate actual installation configuration at time of project completion including all equipment locations, pipe routing, conduit routing, room configurations, etc.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Detection Devices: Not less than 20 percent of amount of each type installed.
2. Container Valves: Not less than 10 percent of amount of each size and type installed.
3. Nozzles: Not less than 20 percent of amount of each type installed.
4. Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.9 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. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Global's "Approval Guide."

C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

D. All devices, components, and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended. The name of the manufacturer, part number, and serial number shall appear on all major components.

E. Locks for all cabinets shall be keyed alike.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide an ECARO-25®, NOVEC 1230®, IG-55, or HFC-227ea or comparable product by one of the following manufacturers:

1. Chemetron Fire Systems; a UTC Fire & Security company.
2. Ansul.
3. Pem All Fire Extinguisher Corporation; a division of Pem Systems Inc.
4. Siemens Building Technologies, Inc.; Fire Safety Division.
5. 3M

B. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity above the ceiling, below the ceiling, and below the raised floor. System includes separate zones above and below the ceiling and beneath the raised floor. If smoke is detected below the raised floor, extinguishing agent shall be discharged in the underfloor zone only. If smoke is detected below the ceiling, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.

C. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, and C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

D. Performance Requirements: (HFC-227ea per NFPA 2001).

1. Minimum design concentration: 9% by volume in all areas and/or protected spaces at the minimum anticipated temperature within the protected area.
2. Per NFPA 2001, the system design shall not exceed a maximum exposure limit concentration level of 10.5% by volume, unless provisions for room evacuation before agent release are provided. All personnel should be able to leave the protected space prior to the discharge or at least within 5 minutes of the commencement of discharge.

E. Performance Requirements: (FE-125 per NFPA 2001).

1. Minimum design concentration: 8% by volume in all areas and/or protected spaces at the minimum anticipated temperature within the protected area.
2. Per NFPA 2001, the system design shall not exceed a maximum exposure limit concentration level of 11.5% by volume, unless provisions for room evacuation before agent release are provided. All personnel should be able to leave the protected space prior to the discharge or at least within 5 minutes of the commencement of discharge.

F. Performance Requirements: (IG-55 per NFPA 2001).

1. Minimum design concentration: 34.2% by volume in all areas and/or protected spaces at the minimum anticipated temperature within the protected area.
2. Per NFPA 2001, the system design shall not exceed a maximum exposure limit concentration level of 43% by volume, unless provisions for room evacuation before agent release are provided. All personnel should be able to leave the protected space prior to the discharge or at least within 5 minutes of the commencement of discharge.

G. Performance Requirements: (NOVEC 1230 per NFPA 2001).

1. Minimum design concentration: 4.7% by volume in all areas and/or protected spaces at the minimum anticipated temperature within the protected area.
2. Per NFPA 2001, the system design shall not exceed a maximum exposure limit concentration level of 10% by volume, unless provisions for room evacuation before agent release are provided. All personnel should be able to leave the protected space prior to the discharge or at least within 5 minutes of the commencement of discharge.

H. Seismic Performance: Fire-suppression piping and containers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

I. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.

2.2 SYSTEM OPERATING SEQUENCE

A. Verified Detection:

1. Actuating First Detector (Alarm):
   a. Visual and audible indication on control panel.
   b. Visual indication on optional annunciator panel.
   c. Energize audible and visual alarms inside the protected hazard area (unique pattern).
   d. Transfer relays to shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.
2. Actuating Second Detector (Pre-discharge):
   a. Visual and audible indication on control panel.
   b. Visual indication on optional annunciator panel.
   c. Energize audible and visual alarms inside the protected hazard area (unique pattern).
   d. Transfer relays to shut down power to protected equipment.
   e. Start time delay for extinguishing-agent discharge for 30 seconds.
   f. Initiate system abort sequence.
3. Extinguishing-agent discharge (Release): Pre-discharge time delay expires or manual release switch is operated.
   a. Visual and audible indication on control panel.
   b. Visual indication on optional annunciator panel.
   c. Energize audible and visual alarms inside and outside the protected area (unique pattern).
   d. Release clean agent suppression system agent.
   e. Release pre-action valve to allow water to fill sprinkler system.

B. Supervisory signal initiation shall be by one or more of the following devices and systems:

1. Clean agent container low pressure switch.
2. Double interlock preaction system low pressure switch.

C. Trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.

2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal AC voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

D. System Supervisory and Trouble Signal Actions:

1. Visual and audible indication on control panel.
2. Visual indication on optional annunciator panel.
3. Transfer relays to send signal to fire-alarm system.

E. Operating manual release switches will cause the immediate discharge of the extinguishing agent, overriding the system's discharge time delay and abort functions. Panel operation shall duplicate the extinguishing-agent discharge sequence described in the previous paragraphs.

1. Electric manual release switches shall be located at each hazard exit.

F. Operating abort switches will delay extinguishing-agent discharge while being activated. Release of hand pressure on the switch will cause agent discharge if the discharge time delay has expired.

G. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.

2.3 PIPING MATERIALS

A. See "Writing Guide" Article in the Evaluations for a discussion on the Section Text's organization and the most efficient way to revise the Section Text. See "Manufacturer's Installation Manual" Article for applications of pipe, tube, fitting, and joining materials.

B. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section 4.2 "Distribution," for charging pressure of system.

2.4 PIPE AND FITTINGS

A. Steel Pipe: ASTM A-106, Seamless, Grade A; ASTM A-106, Seamless, Grade C; ASTM A-53, ERW, Grade A; Schedule 40.

1. Threaded Fittings:

a. Malleable-Iron Fittings: ASME B16.3, Class 300.
b. Flanges and Flanged Fittings: ASME B16.5, Class 300.

c. Fittings Working Pressure: 416 psig minimum.
d. Threaded malleable or ductile iron: Class 300
e. Flanged Joints: Class 300 minimum.

2. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

B. Steel Pipe: ASTM A-106, Seamless, Grade A; ASTM A-106, Seamless, Grade C; ASTM A-53, ERW, Grade A; Schedule 40.

1. Threaded Fittings:

   a. Malleable-Iron Fittings: ASME B16.3, Class 300.
   b. Flanges and Flanged Fittings: ASME B16.5, Class 300.
   c. Fittings Working Pressure: 500 psig minimum.
   d. Threaded malleable or ductile iron: Class 300
   e. Flanged Joints: Class 300 minimum.

2. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

C. Steel Pipe: ASTM A-106, Seamless, Grade A; ASTM A-106, Seamless, Grade C; ASTM A-53, ERW, Grade A; Schedule 80 or 160.

1. Threaded Fittings :

   a. Forged Steel Fittings: ASME B16.3, Class 2000 and Class 3000.
   b. Flanges and Flanged Fittings: ASME B16.5, Class 1500.
   c. Fittings Working Pressure: 2900 psig or minimum, upstream of the pressure reducer. Pressure rating downstream of pressure reducer determined by system flow calculations.
   d. Flanged Joints: Class 1,500 minimum.

2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

D. 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 (3.2-mm) maximum thickness unless thickness or specific material is indicated.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.5 VALVES

A. General Valve Requirements:

1. UL listed or FM Approved for use in fire-protection systems.
2. Compatible with type of clean agent used.
3. Automatic excessive pressure relief provision.
4. Low pressure gauge.

B. Container Valves: With fast acting rupture disc with solenoid actuator and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.6 EXTINGUISHING-AGENT CONTAINERS

A. Description: High strength alloy steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.

1. Finish: Manufacturer's standard color, enamel or epoxy paint.
2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
3. Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
4. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

B. Location: Located within hazard area, or as near as possible to reduce the required amount of pipe and fittings.

2.7 FIRE-EXTINGUISHING CLEAN AGENT

A. HFC-227ea Clean Agent: Heptafluoropropane.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Fike®; HFC-227ea or comparable product by one of the following:

   a. DuPont.
   b. Great Lakes Chemical Corporation; a Chemtura company.

B. HFC-125 Clean Agent: Pentafluoroethane.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Fike®; ECARO-25™ or comparable product.

C. IG-55 Clean Agent: Mixture of nitrogen and argon inert gases.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Fike®; PROINERT® or PROINERT®2 or comparable product.

2.8 DISCHARGE NOZZLES

A. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.

2.9 MANIFOLD AND ORIFICE UNIONS

A. Description: NRTL-listed device with minimum 2175-psig pressure rating, to control flow and reduce pressure of IG-55 gas in piping.

1. NPS 2 and Smaller: Piping assembly with orifice, sized for system design requirements.
2. NPS 2-1/2 and Larger: Piping assembly with nipple, sized for system design requirements.

2.10 CONTROL PANELS

A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system. Listed and approved for releasing service, and suitable for deluge/pre-action sprinkler service.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Fike®; SHP-PRO® or comparable product.

B. Power Requirements: 120-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for initiating devices, notification appliances, trouble signals, supervisory signals, digital alarm communicator transmitter, and auxiliary power.

1. Alarm current draw of the entire clean agent suppression system shall not exceed 80 percent of the control panel's power supply rating.

C. Enclosure: NEMA ICS 6, Type 1, steel cabinet.

1. Mounting: Surface.
2. Finish: Red baked on enamel finish

D. Supervised Circuits: Wired NFPA 72, Class B

1. Two detection circuits; capable of cross zone; sequential; single detector release actuation methods.
2. Three initiating device circuits; capable of monitoring contact closure devices.
3. Three notification appliance circuits.
4. Agent release circuit capable of actuating suppression system.
5. Solenoid release circuit capable of actuating suppression system or sprinkler solenoids.
6. Auxiliary power circuit (resettable/non-resettable) for field devices.
7. Three Form-C relay contacts for auxiliary control functions.
8. Eight additional Form-C relay contacts with addition of supplemental relay cards.

E. Control-Panel Features:

1. Microprocessor controlled.
2. Ten LED indicators to provide positive indication of system status.
3. Diagnostic LED indicator to display system and trouble events.
4. Configurable via dip-switches.
5. Automatic switchover to standby power at loss of primary power.
6. Storage container, low-pressure indicator.
7. Service disconnect to interrupt system operation for maintenance with visual status indication on the panel.
8. Silence and reset switch.
9. 120 VAC or 240 VAC power input.
10. Five optional abort types.
11. Simultaneous monitoring and release of clean agent and sprinkler suppression systems.

F. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless-steel or aluminum enclosure.

G. Standby Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium, sized to operate system for 24 hours and alarm for minimum of 15 minutes.

H. Optional Cards: Cards mount directly to and receive their operational power from the SHP PRO® control board.

1. Class A Input Module: Converts all five initiating devices circuits to NFPA 72, Class A wiring.
2. Class A Output Module: Converts all three notification appliance and releasing circuits to NFPA 72, Class A wiring.
3. Relay Module: Provides four additional Form-C relay contacts for auxiliary control functions.

2.11 SYSTEM SMOKE DETECTORS

A. General Requirements:

1. Comply with NFPA 2001, NFPA 72, and UL 268.
2. 24-V dc, nominal.
3. Two-wire type.
4. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.

C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

D. Base Mounting: Detector shall be mounted on a twist-lock, fixed base.

1. Select according to operational characteristics: Verified detection, Cross-zone detection, and Single-detector release.
2. Base provides terminals for connection to control unit.

E. Signals to the Central Fire Alarm Control Panel: Any type of local system Alarm, Trouble, or Supervisory event is reported to the central fire alarm control panel as a composite signal for each event type.

2.12 HEAT DETECTORS

A. General Requirements:

1. Comply with NFPA 2001, NFPA 72, and UL 521.
2. 24-V dc nominal.
3. Two-wire type.
4. Self-restoring: Detectors do not require resetting after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power on status.

B. Fixed Temperature Type: Actuated by a temperature that exceeds a fixed temperature of 135 deg F (57 deg C).

C. Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 12 deg F (11 deg C) per minute unless otherwise indicated.

A. Base Mounting: Detector shall be mounted on a twist-lock, fixed base.

1. Select according to operational characteristics: Verified detection, Cross-zone detection, and Single-detector release.
2. Base provides terminals for connection to control unit.

2.13 LINEAR HEAT DETECTION

A. General Requirements:

1. Comply with NFPA 2001, NFPA 72, and UL 521.
2. Temperature Rating: Actuated by a temperature that exceeds a fixed temperature of 155 deg F (68 deg C).
3. Connects to the control panels detection and input circuits; providing a contact closure input.

2.14 SWITCHES

A. General Description: Surface FM Approved or NRTL listed, low voltage, includes contacts for connection to control panel.

B. Manual Release Switch: Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

1. Stainless steel faceplate.
2. Dual-action requiring two distinct operations to initiate suppression system release.
3. Red plastic release button, keyed reset.
4. "MANUAL RELEASE" caption.

C. Abort Switch: Unit can manually prevent the release of the suppression system while pressed.

1. Stainless steel faceplate.
2. Red plastic abort button, momentary contact (dead-man type).
3. Available with key-operated switch.
4. "SYSTEM ABORT" caption.

D. Main-Reserve Switch: Unit allows transfer of release circuit signal from main supply to reserve supply.

1. Stainless steel faceplate.
2. Black plastic selector button (main/reserve)
3. "CONTAINER SELECT" caption.

E. EPO Switch:
1. Clear faceplate with hinged cover.
2. "EPO" caption, with yellow finish.

F. Low-Agent Pressure Switches: Installed on extinguishing agent container; pneumatic operation.

G. Suppression Disconnect Switches: Unit enables releasing circuit (i.e., clean agent or sprinkler) to be disconnected from the control panel.

1. Stainless steel faceplate.
2. Key operated selector switch (armed/disarmed).
3. LEDs to provide indication of switch status (armed/disarmed).
4. "SUPPRESSION DISCONNECT" caption.

H. Discharge Pressure Switches: Installed on suppression piping to provide indication of manual actuation of the clean agent suppression system back to the control panel.

2.15 ALARM DEVICES

A. General Requirements: Listed and labeled by an NRTL or FM Approved, low voltage, and surface mounting.

B. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly. Connected to notification appliance signal circuits, equipped for mounting as indicated and with screw terminals for system connections.

C. Bells, comply with UL 464: High dBa output; 24-V dc; vibrating type; minimum 6-inch diameter. Bells shall produce a sound-pressure level of 90 dBa minimum, measured 10 feet (3 m) from horn.

D. Horns, comply with UL 464: Electric-vibrating-polarized type, 24-V dc. Horns shall produce a sound-pressure level of 90 dBa minimum, measured 10 feet (3 m) from horn.

E. Visible Notification Appliances, comply with UL 1971: Xenon strobe lights with translucent lens, with "FIRE" or similar caption.

1. Rated Light Output:
   a. Indicated on drawings.
   b. 15/30/75/110 cd, selectable in the field.
2. Mounting: Indicated on Drawings.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finish, red.

2.16 INFORMATIONAL SIGNAGE

A. Provide informational signs as required to comply with NFPA 2001 for the specific agent.

2.17 ANNUNCIATOR PANEL

A. Description: Annunciator shall provide a graphic display of the protected area, and shall provide LEDs to indicate the location of system detectors.

1. Mounting: Steel enclosure; black finish; flush or surface mounted.

2.18 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Features:

1. 100 event history buffer.
2. Communication Protocols: Modem IIIa^2, SIA, and 4/2
3. LEDs for heartbeat, system trouble, and telephone line trouble (one per line).
4. Dual telephone line interface.
5. Self-Test: Conducted automatically every 10 minutes with report transmitted to central station.
6. Communication failure indication.
7. Operating Power: 24-V dc continuous power from control panel.

C. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from the control panel and automatically capture one telephone line(s) and dial a preset number for a remote central station. When contact is made with the central station, signals shall be transmitted. If service on either line is interrupted for longer than 36 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

D. Mounting: Digital alarm communicator transmitter must be mounted adjacent to the control panel within 20 feet (6.1 m) with interface wiring in conduit.

E. Secondary Power: Auxiliary power supply with integral rechargeable battery and automatic charger; UL listed for Fire Protective Signaling System service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.

1. The general contractor shall be responsible for sealing and securing the protected enclosure against agent loss and/or leakage during the required agent "hold' period.

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

3.2 PIPING APPLICATIONS

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

C. NPS 2-1/2 and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints or steel, grooved-end fittings; and grooved joints.

3.3 PIPING APPLICATIONS

A. Piping between Storage Containers and Orifice Union: Schedule 160, steel pipe; forged-steel welding fittings; and welded joints or malleable-iron fittings with threaded or flanged joints.

B. Piping Downstream from Orifice Union: Schedule 80, steel pipe; forged-steel welding fittings; and welded joints or malleable-iron fittings with threaded or flanged joints.

3.4 CLEAN-AGENT PIPING INSTALLATION

A. Install clean-agent extinguishing piping and other components level and plumb, according to manufacturers' written instructions.

B. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

C. Grooved Piping Joints: Groove pipe ends according to AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant according to manufacturer's written instructions.

D. Install extinguishing-agent containers anchored to substrate.

E. All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male threads only.

F. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001, Section 4.2 "Distribution."

1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
2. Support piping using supports and methods according to NFPA 13.
3. Install seismic restraints for extinguishing-agent containers and piping systems.

3.5 DETECTION, ACTUATION, ALARM, AND CONTROL SYSTEMS INSTALLATION

A. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 72 and NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

B. Smoke or Heat Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat detector spacing.
3. Smoke ceiling spacing shall not exceed 30 feet (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

C. Audible Alarm-Indicating Devices: Wall mounted with tops above the finished floor not less than 90 inches (2.29 m), and below the ceiling not less than 6 in. (150 mm). Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

D. Visible Alarm-Indicating Devices: Wall mounted with entire lends not less than 80 in. (2.03 m) and not greater than 96 in. (2.44 m) above the finished floor. Where ceiling height does not permit mounting at minimum height, mount within 6 inches (150 mm) of the ceiling.

E. Combination Audible-Visual Devices: Where combination audible and visual devices are used, mount devices according to Visual Alarm-Initiating Device requirements.

F. Control Unit: Surface mount, with top of cabinet not more than 72 inches (1830 mm) above the finished floor.

G. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Connect electrical devices to control panel and to building's fire-alarm system.

3.7 IDENTIFICATION

A. Identify system components, equipment, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.

C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.

D. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

E. Install framed operating instructions in a location visible from control unit.

3.8 SYSTEM WIRING

A. Wiring shall be installed by qualified individuals, in a neat and workmanlike manner in accordance with the National Electrical Code (NEC), Article 725 and 760, except as otherwise permitted for limited energy circuits as described in NFPA 72. Installation shall meet all local, state, province and/or country codes.

B. All wiring shall be installed in electrical metallic tubing (EMT) or conduit, and must be kept separate from all other building wiring. Runs of conduit shall be straight, neatly arranged, properly supported and installed parallel and perpendicular to walls and partitions.

C. Conductors shall be sized according to the design documents and color coded to allow easy circuit identification.

D. All wires shall be tagged at all junction boxes.

E. All wires shall be tested for the presence of opens, shorts and grounds prior to connection to control panel. Final wire terminations to control panel shall be made under the direct supervision of a factory trained representative.

F. All system components shall be securely supported independent of the wiring.

G. Ground control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to control panel.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Submit test plan for review and approval by the owner or owner's designated representative prior to performing tests.

E. Detection, Actuation, Alarm, and Control Systems Tests:

1. Visual Inspection: Conduct the visual inspection prior to testing.

   a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in it "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamental of Fire Alarm Systems" Chapter.
   b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in FNPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. Operational Test: After electrical circuitry has been energized, apply power to control panel and confirm proper unit operation. Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing, and Maintenance" Chapter in NFPA 72.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Clean-Agent Fire Extinguishing Systems Test:

1. Flow Test: Using nitrogen or other inert gas, perform a flow test on the piping network to verify that flow is continuous and unobstructed through piping and nozzles.
2. Pressure/Leak Test: pneumatically test the piping in a closed circuit for a period of 10 minutes at 40 psi (276 kPa). At the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure. Repair leaks and retest until no leaks exist.
3. Room Pressurization Test: After all construction work is complete, conduct a room pressurization test in accordance with NFPA 2001 in each clean agent suppression system hazard area. Test shall confirm enclosures ability to retain the agent concentration level for the required hold time. If the test fails, the suppression system contractor shall coordinate room sealing with the general contractor. Additional tests shall be conducted until successful test results are achieved. Include final test results in project 'Closeout Submittals'.

G. System will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports: Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection

and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the clean-agent fire-extinguishing systems.

3.11 SERVICE CONTRACT

A. Suppression system installing contractor shall provide two (2) inspections of the systems installed under this contract, during the manufacturer's one-year warranty period. The first inspection shall be at the six month interval, and the second shall be at the twelve month interval after system acceptance.

B. Inspections shall be conducted in accordance with the equipment manufacturer's guidelines and the recommendations of NFPA 72 and NFPA 2001. Use forms provided in NFPA 72 for initial tests and inspections.

C. Prepare and submit test and inspection reports.

3.12 WARRANTY

A. Clean Agent System manufacturer shall guarantee all components furnished under this contract against defects in design, materials, and workmanship for no less than one (1) year from the date of system acceptance.

END OF SECTION 212200

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

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.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 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.

2.3 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: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

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 079200 "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 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 1 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 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: Galvanized-steel-pipe sleeves .
   b. Piping NPS 6 and Larger: Cast-iron wall 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 .

      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.

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 .

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

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. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 220518

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe positioning systems.
7. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 .

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
1. Clevis
2. Fee and Mason
3. Anvil
4. PDH Manufacturing, Inc,.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel .

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel .

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cooper B-Line, Inc.; a division of Cooper Industries.
   b. Unistrut; an Atkore International company.

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

2.5 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: 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 and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig 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.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 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 anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Cast-in-place anchor system: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating. Anchor shall have a protective sleeve, steel flange with predrilled additional fastening holes and placement spring for attachment to metal deck. Anchor is to be secured by clamping the deck between the steel flange and the protective plastic sleeve. Anchor shall bear the diameter and manufacturer name on its hexagon head. Anchor shall be similar to HCI-MD as supplied by Hilti.

2.7 PIPE POSITIONING SYSTEMS

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

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. 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 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 attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches .

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. 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.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

1. Self-regulating, parallel resistance.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For electric heating cable.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chromalox, Inc.
2. Raychem; Tyco Thermal Controls.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F .

G. Maximum Exposure Temperature (Power Off): 185 deg F .

H. 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.

I. Capacities and Characteristics:

1. Refer to schedules for all capacities and characteristics

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F .
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

B. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:

1. Automatic control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows:

   a. Temperature Span: 34 to 44 deg F .
   b. Adjustable Delay-Off Span: 30 to 90 minutes.
   c. Energize Cables: Following two-minute delay if ambient temperature is below set point and precipitation is detected.

d. De-Energize Cables: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to energize cable or close other contactors.
5. Precipitation sensor shall be freestanding.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

C. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:

1. Microprocessor based.
2. Minimum of four separate schedules.
3. Minimum 24-hour battery carryover.
4. On-off-auto switch.
5. 365-day calendar with 20 programmable holidays.
6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control-system workstation.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Snow and Ice Melting on Roofs and in Gutters and Downspouts: Self-regulating, parallel-resistance heating cable.
2. Temperature Maintenance for Domestic Hot Water: Self-regulating, parallel-resistance heating cable.

3.2 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Snow and Ice Melting on Roofs and in Gutters and Downspouts: Install on roof and in gutters and downspouts with clips furnished by manufacturer that are compatible with roof, gutters, and downspouts.

C. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Hot Water:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install insulation over piping with electric heating cables according to Section 220719 "Plumbing Piping Insulation."
3. Install warning tape on piping insulation where piping is equipped with electric heating cables.

E. Set field-adjustable switches and circuit-breaker trip ranges.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Remove and replace damaged heat-tracing cables.

END OF SECTION 220533

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

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. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. 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: White.
3. Background Color: Black.

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.
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-quarters the size of principal lettering.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information plus emergency notification instructions.

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 formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

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 aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain 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. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

1. Domestic Water Piping

   a. Background: Safety green.
   b. Letter Colors: White.

2. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Safety white.
   b. Letter Color: Black.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches, round.
   b. Hot Water: 1-1/2 inches, round.

2. Valve-Tag Colors:

   a. Cold Water: Safety Green.
   b. Hot Water: Safety Green.

3. Letter Colors:

   a. Cold Water: White.
   b. Hot Water: White.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Roof drains bodies (primary & overflow)
5. Horizontal portions of storm drain piping (primary & overflow)
6. Condensate drains
7. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 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.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. 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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.3 SEALANTS

A. ASJ 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.

2.4 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.

2.5 FIELD-APPLIED JACKETS

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

B. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Outdoor Applications: 3-mil- thick polysurlyn.
d. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.6 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.

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

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

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. 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.

P. Continuously insulate

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

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

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

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

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

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange

cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install 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 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.8 FIELD-APPLIED JACKET INSTALLATION

A. 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 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Underground piping.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
3. Chemical Waste
4. Drainage piping located in crawl spaces.
5. Vertical portions of storm drain piping (unless needed for acoustical performance)

C. PVC Jackets shall be installed on insulated piping in conjunction with the fitting covers to provide a total sealed system as required by USDA and FDA for applications in food processing and pharmaceutical facilities. Does not apply to facilities not governed by USDA or FDA guidelines.

D. Insulate cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self-sealing laps.
   1. Domestic cold water
   2. Roof drain bodies (primary & overflow)
   3. Horizontal portions of storm drain piping (primary & overflow)
   4. Chilled water
   5. Condensate drain

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

   1. NPS 1 and Smaller: Insulation shall be the following:

      a. Mineral-Fiber, Preformed Pipe Insulation, ASTM C547, Type I: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, ASTM C547, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, ASTM C547, Type I: 1/2 inch thick.

2. NPS 1-1/2 and Larger: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, ASTM C547, Type I: 1 inch thick.

C. Coil Condensate Drain:

1. All Sizes: Insulation shall be the following:

   a. Mineral-Fiber, Performed Pipe Insulation, ASTM C547, Type I: 1/2 inch thick.

D. Stormwater and Overflow:

1. All Pipe Sizes: Insulate horizontal rain water leaders from the roof drain. Insulation shall be one of the following:

   a. Flexible Elastomeric: 1 inch thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Roof Drain and Overflow Drain Bodies:

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

F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: See plumbing fixture schedule on plans.

G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, ASTM C547, Type I: 1/2 inch thick.

3.12 OUTDOOR, ABOVE GROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, ASTM C547, Type I: 2 inches thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping:

1. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

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. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

C. Certificates: Certificate indicating that the PEX-a installer is authorized to install the manufacturer's products.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documents specified herein.

B. Operation and maintenance data.

1.6 WARRANTY

A. For PEX piping systems, provide a limited warranty of 25 years for all PEX tubing and associated fittings when installed by a manufacturer trained contractor and certified plumbing professional.

1.7 QUALITY ASSURANCE

A. Provide a domestic water system that complies with International Code Conference (ICC) – International Plumbing Code (IPC).

B. PEX Installer Qualifications: Use an installer with demonstrated experience on projects of similar size and complexity and possessing documentation proving successful completion of PEX plumbing installation training by the PEX tubing manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

D. Store PEX tubing in cartons or under cover to avoid dirt or foreign material from being introduced into the tubing.

E. Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, provide cover to portions of tubing exposed to direct sunlight.

1.9 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 PEX TUBE AND FITTINGS

A. Manufacturer: Uponor.

B. Tubing:

1. Material: Crosslinked polyethylene (PEX) manufacturer by PEX-a or Engel method. PEX-b and PEX-c is not allowed.
2. Type: Wirsbo AQUAPEX.
3. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third party agency.
4. Standard grade hydrostatic design and pressure ratings from PPI.
5. Fire-rated assembly listings in accordance with ANSI/UL 263.

    a. UL Design No. L557 — 1-hour wood frame floor/ceiling assemblies.
    b. UL Design No. K913 — 2-hour concrete floor/ceiling assemblies.
    c. UL Design No. U372 — 1-hour wood stud/gypsum wallboard wall assemblies.
    d. UL Design No. V444 — 1-hour steel stud/gypsum wallboard wall assemblies.

6. Minimum Bend Radius (cold bending): No less than six times the outside diameter. Use a bend support as supplied by the PEX tubing manufacturer for tubing with a bend radius less than stated.
7. Nominal Inside Diameter: Provide tubing with nominal inside diameter, in accordance with ASTM F876 as indicated.

    a. ⅜ inches.
    b. ½ inches.
    c. ¾ inches.
    d. 1 inches.
    e. 1¼ inches.
    f. 1½ inches.
    g. 2 inches.
    h. 2½ inches.
    i. 3 inches.

C. Fittings for PEX Tube:

1. Material: Fitting assembly shall be manufactured from material listed in paragraph 5.1 of ASTM F1960.
2. Material Standard: Comply with ASTM F 1960.
3. Type: PEX-a cold expansion fitting.

a. Assembly consists of the appropriate ProPEX insert with a corresponding ProPEX Ring and matching PEX tube dimensions.

4. Crimp fittings are not allowed.

D. Manifold:

1. Material: Uponor engineered plastic (EP) body with ProPEX outlet connections.
2. Manifold Type: Uponor engineered plastic (EP) manifold.
3. All manifolds shall be manufactured with the appropriate-sized ProPEX fittings on the manifold supply inlets.

E. Accessories:

1. Angle stops and straight stops that are compatible with PEX tubing are supplied by the PEX tubing manufacturer.
2. Bend supports designed for maintaining tight radius bends are supplied by the PEX tubing manufacturer.
3. ProPEX expander tool to install the ASTM F1960 compatible fittings are supplied by the PEX tubing manufacturer.
4. The tubing manufacturer provides clips and/or PEX rails for supporting tubing runs.
5. All horizontal tubing hangers and riser clamps are epoxy-coated material.
6. Fixture pipe termination: Tubing manufacturer wall bracket with PEX stub-outs.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

2.5 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries, Inc.
e. Romac Industries, Inc.
f. Smith, Jay R. Mfg. Co.
g. Smith-Blair, Inc.
h. Viking Johnson.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Uponor.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A.Y. McDonald Mfg. Co.
b. Capitol Manufacturing Company.
c. Central Plastics Company.
d. HART Industrial Unions, LLC.
e. Jomar Valve.

f. Matco-Norca.
g. Watts; a Watts Water Technologies company.
h. Wilkins.
i. Zurn Industries, LLC.

2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig minimum at 180 deg F.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Matco-Norca.
d. Watts; a Watts Water Technologies company.
e. Wilkins.
f. Zurn Industries, LLC.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elster Perfection Corporation.

b. Grinnell Mechanical Products.
c. Matco-Norca.
d. Precision Plumbing Products.
e. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

C. Install shutoff valve immediately upstream of each dielectric fitting.

D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

H. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

J. Install piping to permit valve servicing.

K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

L. Install piping free of sags and bends.

M. Install fittings for changes in direction and branch connections.

N. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

O. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

P. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

T. Do not install domestic water piping over electrical equipment.

U. PEX

1. Comply with manufacturer's product data, including product technical bulletins, installation instructions, design drawings and the Uponor Professional Plumbing Installation Guide.
2. Install Wirsbo AQUAPEX tubing in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.

3. Do not install PEX tubing within 6 inches of gas appliance vents or within 12 inches of any recessed light fixtures.
4. Do not solder within 18 inches of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections.
5. Do not expose PEX tubing to direct sunlight for more than 30 days.
6. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.
7. Use grommets or sleeves at the penetration for PEX tubing passing through metal studs.
8. Protect PEX tubing with sleeves where abrasion may occur.
9. Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail.
10. Use tubing manufacturer-supplied bend supports where bends are less than six times the outside tubing diameter.
11. Minimum horizontal supports are installed not less than 32 inches between hangers in accordance with model plumbing codes and the installation handbook.
12. PEX riser installations require epoxy-coated riser clamps installed at the base of the ceiling per floor.
13. A mid-story support is required for riser applications.
14. Pressurize Wirsbo AQUAPEX tubing with air in accordance with applicable codes or in the absence of applicable codes to a pressure of 25 psi above normal working pressure of the system.
15. Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Do not use water to pressurize the system if ambient air temperature has the possibility of dropping below 32°F.
16. Through-penetration Firestop
    a. Ensure compliance of one- and two-hour rated through penetration assemblies in accordance with ASTM E814.
    b. A list of firestop manufacturers that list PEX tubing with their firestop systems is available from the PEX tubing manufacturer.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

E. Joints for PEX Piping: Join according to ASTM F 1807.

F. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.

F. Install hangers for vertical PEX piping every 48 inches.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   a. For PEX provide tubing manufacturer's wall bracket and PEX stub-out.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. PEX-a Manufacturer's Field Services: Provide manufacturer's field service consisting of product use recommendations and periodic site visit for inspection of product installation in accordance with manufacturer's instructions.

1. Site Visits: A minimum of two (2), 2-hour site visits.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:

      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

E. PEX-a: Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:

1. PEX-a tube, NPS 2 and smaller; fittings for PEX-a tube; and PEX-a cold expansion fitting.
a. NOTE: PEX TUBING NOT ALLOWED IN HVAC PLENUM SPACES. CONTRACTOR SHALL TAKE CARE AND MAKE ALLOWANCES FOR PROTECTION OF PEX IN WALLS TO AVOID PUNCTURE OR DAMAGE BY OTHER CONSTRUCTION. INSTALLATION SHALL BE PER MANUFACTUERS' RECOMMENDATIONS AND SHALL BE SUPPORTED

AND ROUTED IN A NEAT, UNIFORM MANNER AND SHALL AVOID SAGS AND TIGHT RADIUSED ELBOWS AND BENDS.

D. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
   1. PEX-a tube, NPS 3 and smaller; fittings for PEX-a tube; and PEX-a cold expansion fitting.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

   1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
   2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
   3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
   4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221316 - SANITARY WASTE AND VENT PIPING

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. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

1.3 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.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For drainage system. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ANACO-Husky.
    b. Dallas Specialty & Mfg. Co.
    c. Fernco Inc.
    d. Matco-Norca.
    e. MIFAB, Inc.
    f. Mission Rubber Company, LLC; a division of MCP Industries.
    g. Stant.
    h. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. MG Piping Products Company.

2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Solvent cement 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."

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Shielded, Nonpressure Transition Couplings:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Cascade Waterworks Mfg. Co.
      2) Mission Rubber Company, LLC; a division of MCP Industries.

   b. Standard: ASTM C 1460.
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

4. Pressure Transition Couplings:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Cascade Waterworks Mfg. Co.
      2) Dresser, Inc.
      3) EBAA Iron, Inc.
      4) Ford Meter Box Company, Inc. (The).
      5) JCM Industries, Inc.
      6) Romac Industries, Inc.
      7) Smith, Jay R. Mfg. Co.
      8) Viking Johnson.

   b. Standard: AWWA C219.
   c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   d. Center-Sleeve Material: Manufacturer's standard.
   e. Gasket Material: Natural or synthetic rubber.
   f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) A.Y. McDonald Mfg. Co.
      2) Capitol Manufacturing Company.
      3) Central Plastics Company.
      4) HART Industrial Unions, LLC.
      5) Jomar Valve.
      6) Matco-Norca.
      7) Watts; a Watts Water Technologies company.
      8) Wilkins.
      9) Zurn Industries, LLC.

   b. Description:

      1) Standard: ASSE 1079.
      2) Pressure Rating: 125 psig minimum at 180 deg F.
      3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Capitol Manufacturing Company.
      2) Central Plastics Company.
      3) Matco-Norca.
      4) Watts; a Watts Water Technologies company.
      5) Wilkins.
      6) Zurn Industries, LLC.

   b. Description:

      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 125 psig minimum at 180 deg F.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1) Advance Products & Systems, Inc.
   2) Calpico, Inc.
   3) Central Plastics Company.
   4) Pipeline Seal and Insulator, Inc.

b. Description:

   1) Nonconducting materials for field assembly of companion flanges.
   2) Pressure Rating: 150 psig.
   3) Gasket: Neoprene or phenolic.
   4) Bolt Sleeves: Phenolic or polyethylene.
   5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Elster Perfection Corporation.
      2) Grinnell Mechanical Products.
      3) Matco-Norca.
      4) Precision Plumbing Products.
      5) Victaulic Company.

   b. Description:

      1) Standard: IAPMO PS 66
      2) Electroplated steel nipple.
      3) Pressure Rating: 300 psig at 225 deg F.
      4) End Connections: Male threaded.
      5) Lining: Inert and noncorrosive, propylene.

2.6 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. 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."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install aboveground PVC piping according to ASTM D 2665.

O. PVC piping according to ASTM D 2321 or ASTM D 2665 will not be allowed below grade.

P. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

Q. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads 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.

D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

F. Plastic, Nonpressure-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 Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

   a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
   b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.14 "Check Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one 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 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

6. Spacing for 10-foot 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 copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 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 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

J. Install supports for vertical PVC piping every 48 inches.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing 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.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

5. Install horizontal backwater valves in pit with pit cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
7. 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.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

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.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping serving the discharge of steam condensate and gas fired humidifiers shall be the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints. Piping shall be able to withstand 212 deg F water without degradation.

C. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Aboveground, vent piping serving the discharge of steam condensate and gas fired humidifiers shall be the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints. Piping shall be able to withstand 212 deg F water without degradation.

F. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

G. Aboveground, vent piping NPS 5 and larger shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

H. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

I. Underground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

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. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Through-penetration firestop assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.
7. Grease interceptors.
8. Solids interceptors.

B. Related Requirements:

1. Section 221423 "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

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 NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Josam Company; Josam Div.
   2. Sioux Chief Manufacturing Company, Inc.
   3. Smith, Jay R. Mfg. Co.; Division fo Smith Industries, Inc.

4. Tyler Pipe; Wade Div.

5. Watts Drainage Products Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation..

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

1. ASME A112.36.2M, Cast-Iron Cleanouts:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company; Josam Div.
2. Sioux Chief Manufacturing Company, Inc.
3. Smith, Jay R. Mfg. Co.; Division fo Smith Industries, Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation..

2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Threaded.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Polished Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Extra Heavy Duty.
13. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts :

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company; Josam Div.
2. Sioux Chief Manufacturing Company, Inc.

3. Smith, Jay R. Mfg. Co.; Division fo Smith Industries, Inc.
4. Tyler Pipe; Wade Div.

5. Watts Drainage Products Inc.
6. 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 or raised-head, 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, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. General Floor Drains:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company; Josam Div.
2. Sioux Chief Manufacturing Company, Inc.
3. Smith, Jay R. Mfg. Co.; Division fo Smith Industries, Inc.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation..

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Outlet: Bottom.
8. Top or Strainer Material: Nickel bronze.
9. Top of Body and Strainer Finish: Nickel bronze.
10. Top Shape: Round.
11. Dimensions of Top or Strainer: 6"
12. Top Loading Classification: Medium Duty.
13. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
14. Trap Material: Copper.
15. Trap Pattern: Standard P-trap.
16. .

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

a. Open-Top Vent Cap: Without cap.
b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Floor Drain, Trap Seal

1. Description: Chemically resistant elastomer forming a barrier to minimize the evaporation of the trap of a floor drain. Trap seal shall open to allow drainage and close when there is no flow automatically and without the requirement for electrical power.
2. Size: Same as floor drain outlet.
3. Standards: Trap seal shall be tested per and comply with ASSE 1072.

D. 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.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.7 GREASE INTERCEPTORS

A. Grease Interceptors:

1. Plastic Grease Interceptors:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Green Turtle Americas.

2. Standard: ASME A112.14.3, for intercepting and retaining fats, oils, and greases from food-preparation or -processing wastewater.
3. Plumbing and Drainage Institute Seal: Not required.
4. Body Material: Plastic.
5. Interior Lining: Not required.
6. Exterior Coating: Not required.
7. Flow Rate: 161 gal
8. Grease Retention Capacity: 807 gal
9. Inlet and Outlet Size: 4" NPS
10. End Connections: Hub.
11. Cleanout: Integral or field installed on outlet.
12. Flow-Control Fitting: Not required.
13. Operation: Manual cleaning.

2.8 MOTORS

A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor 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. Set with grates depressed according to the following drainage area radii:

   a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

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.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

H. Assemble open drain fittings and install with top of hub 1 inch above floor.

I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

L. Install vent caps on each vent pipe passing through roof.

M. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

N. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

O. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

P. Install wood-blocking reinforcement for wall-mounting-type specialties.

Q. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

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. Emergency showers.
2. Eyewash equipment.
3. Eye/face wash equipment.
4. Combination units.
5. Supplemental equipment.
6. Water-tempering equipment.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

D. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushing-Fluid Solution: Separate lot and equal to at least **[200] <Insert number>** percent of amount of solution installed for each self-contained unit.

1.8 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. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EMERGENCY SHOWERS

A. Freestanding, Plumbed Emergency Showers,:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Safety.
b. Bradley Corporation.
c. Guardian Equipment Co.

2. Capacity: Not less than 20 gpm for at least 15 minutes.
3. Supply Piping: NPS 1-1/4 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Refer to project details..
5. Shower Head: 8-inch-minimum diameter, chrome-plated brass, stainless steel, or plastic.
6. Mounting: Pedestal.

B. Off-Floor, Plumbed Emergency Showers,:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Acorn Safety.
   b. Bradley Corporation.
   c. Chicago Faucets; Geberit Company.
   d. Guardian Equipment Co.

2. Capacity: Not less than 20 gpm for at least 15 minutes.
3. Supply Piping: NPS 1 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Pull rod.
5. Shower Head: 8-inch-minimum diameter, chrome-plated brass, stainless steel, or plastic.
6. Mounting: Refer to project drawings and details.

2.2 EYEWASH EQUIPMENT

A. Sink, Swivel-Type, Plumbed Eyewash Unit,:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Acorn Safety.
   b. Bradley Corporation.
   c. Guardian Equipment Co.

2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: paddle actuator.
5. Spray-Head Assembly: Two spray heads with offset piping.
6. Mounting: Deck next to sink.

2.3 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment,:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Acorn Safety.
   b. Armstrong International, Inc.
   c. Bradley Corporation.
   d. Guardian Equipment Co.
   e. Leonard Valve Company.
   f. Powers.

2. Description: Factory-fabricated equipment with thermostatic mixing valve.

   a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
   b. Supply Connections: For hot and cold water.

2.4 SOURCE QUALITY CONTROL

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation.

Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

J. Fill self-contained fixtures with flushing fluid.

3.3 CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

C. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

E. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

F. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 224500

SECTION 226113 - COMPRESSED-AIR PIPING FOR LABORATORY FACILITIES

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. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air."

1.3 DEFINITIONS

A. Nonmedical compressed-air piping systems include laboratory air piping systems.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Brazing certificates.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

1.8 PROJECT CONDITIONS

A. Interruption of Existing Laboratory Compressed-Air Service(s): Do not interrupt laboratory compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of laboratory compressed-air service(s).
2. Do not proceed with interruption of laboratory compressed-air service(s) without Owner's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Laboratory air, contractor to confirm operating pressure.

2.2 PIPES, TUBES, AND FITTINGS

A. Comply with ASME B31.1, "Power Piping," for laboratory air piping operating at more than 150 psig.

B. Comply with ASME B31.9, "Building Services Piping," for laboratory air piping operating at 150 psig or less.

C. Copper Medical Gas Tube: ASTM B 819, Type K and Type L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.

D. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

E. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

F. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, full-face type.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

G. Shape-Memory-Metal Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Aerofit, Inc.
   b. Smart Tap; Smart Technology, Inc.

2. Description: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

H. Flexible Pipe Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flex-Hose Co., Inc.
   b. Flexicraft Industries.
   c. Hyspan Precision Products, Inc.
   d. Mercer Rubber Co.
   e. Metraflex Company (The).
   f. Proco Products, Inc.
   g. Unaflex.
   h. Universal Metal Hose.

2. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

   a. Working-Pressure Rating: 200 psig minimum.
   b. End Connections: Plain-end copper tube.

2.3 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

2.4 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Healthcare Products Inc.
b. Amico Corporation.
c. Apollo Valves; Conbraco Industries, Inc.
d. BeaconMedaes.
e. Marwin Valve; Richards Industries.
f. NIBCO INC.
g. Ohio Medical Corporation.
h. Tri-Tech Medical.

2. Standard: MSS SP-110.
3. Description: Three-piece body, brass or bronze.
4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
7. Handle: Lever.
8. Stem: Blowout proof with PTFE or TFE seal.
9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Healthcare Products Inc.
b. Amico Corporation.
c. Apollo Valves; Conbraco Industries, Inc.
d. BeaconMedaes.
e. Ohio Medical Corporation.
f. Tri-Tech Medical.

2. Description: In-line pattern, bronze.
3. Pressure Rating: 300 psig minimum.
4. Operation: Spring loaded.
5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Safety Valves:

1. Bronze body.
2. ASME-construction, poppet, pressure-relief type.
3. Settings to match system requirements.

E. Pressure Regulators:

1. Bronze body and trim.
2. Spring-loaded, diaphragm-operated, relieving type.
3. Manual pressure-setting adjustment.
4. Rated for [**250-psig**] **<Insert value>** minimum inlet pressure.
5. Capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

2.5 NITROGEN

A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Comply with NFPA 99 for installation of compressed-air piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install compressed-air piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and for branch connections.

O. Piping Restraint Installation: Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

P. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

Q. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

R. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.

B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on compressed-air piping where reduced pressure is required.

F. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

3.3 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

B. Threaded Joints: Apply appropriate tape to external pipe threads.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

D. Flanged Joints: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

3.4 COMPRESSED-AIR SERVICE COMPONENT INSTALLATION

A. Install compressed-air pressure control panel in walls. Attach to substrate.

B. Install compressed-air manifolds on concrete base anchored to substrate.

C. Install compressed-air cylinders and connect to manifold piping.

D. Install compressed-air manifolds with seismic restraints as indicated.

E. Install compressed-air-cylinder wall storage racks attached to substrate.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or Type 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch-minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.6 IDENTIFICATION

A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL FOR COMPRESSED-AIR PIPING IN NONMEDICAL LABORATORY FACILITIES

A. Testing Agency: Engage qualified testing agency to perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and to prepare test and inspection reports.

B. Tests and Inspections:

1. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill compressed-air piping with oil-free dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect filters and pressure regulators for proper operation.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.8 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.9 PIPING SCHEDULE

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Flanges may be used where connection to flanged equipment is required.

C. Medical Air Piping except Instrument Air Piping Larger Than NPS 3 and Operating at More Than 185 psig : Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.10 VALVE SCHEDULE

A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

B. Zone Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION 226113

SECTION 226213 - VACUUM PIPING FOR LABORATORY FACILITIES

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. Laboratory low-vacuum piping, designated "laboratory low vacuum."
   2. Laboratory high-vacuum piping, designated "laboratory high vacuum."

1.3 DEFINITIONS

A. HVE: High-volume (oral) evacuation.

B. Nonmedical laboratory vacuum piping systems include laboratory low-vacuum and laboratory high-vacuum piping systems.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Brazing certificates.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Pressure-Seal Joining Procedure for Copper Tubing: An authorized representative who is trained and approved by manufacturer.
   2. Extruded-Tee Outlet Procedure: An authorized representative who is trained and approved by manufacturer.
   3. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

1.8 PROJECT CONDITIONS

A. Interruption of Existing Laboratory Vacuum Service(s): Do not interrupt laboratory vacuum service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

   1. Notify Owner no fewer than two days in advance of proposed interruption of laboratory vacuum service(s).
   2. Do not proceed with interruption of laboratory vacuum service(s) without Owner's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Laboratory low vacuum, contractor to confirm operating pressure.

B. Laboratory high vacuum, contractor to confirm operating pressure.

2.2 PIPES, TUBES, AND FITTINGS

A. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.

B. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service.

C. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

D. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

E. Shape-Memory-Metal Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Aerofit, Inc.
   b. Smart Tap; Smart Technology, Inc.

2. Description: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

F. Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Viega LLC.

2. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
3. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

G. Extruded-Tee Outlets: ASTM F 2014 procedure for making branch outlets in copper tube.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. T-DRILL Industries Inc.

H. PVC Pipe: ASTM D 1785, Schedule 40.

I. PVC Fittings: ASTM D 2466, Schedule 40; socket type.

J. Transition Fittings: PVC socket type with copper threaded insert on one end.

K. Flexible Pipe Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flex-Hose Co., Inc.

b. Flexicraft Industries.
c. Hyspan Precision Products, Inc.
d. Mercer Rubber Co.
e. Metraflex Company (The).
f. Proco Products, Inc.
g. Unaflex.
h. Universal Metal Hose.

2. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

a. Working-Pressure Rating: 200 psig minimum.
b. End Connections: Plain-end copper tube.

2.3 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

C. Threaded-Joint Tape: PTFE.

D. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 NITROGEN

A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and

calculate friction loss, expansion, vacuum producer sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Comply with NFPA 99 for installation of vacuum piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install vacuum piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.

O. Piping Restraint Installation: Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

P. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

Q. Install unions in copper vacuum tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.

R. Install unions in PVC vacuum piping NPS 2 and smaller adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.

S. Install flanges in PVC vacuum piping NPS 2-1/2 and larger adjacent to flanged valves and at final connection to each machine, specialty, and piece of equipment.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from vacuum equipment and specialties.

B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Apply appropriate tape to external pipe threads.

E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Do not use flux. Continuously purge joint with oil-free dry nitrogen during brazing.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

G. PVC-to-Copper Joints: Join transition fitting PVC socket end as solvent-cemented joint to PVC pipe and join fitting end with insert to copper tube as threaded joint.

H. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by tube manufacturer.

I. Flanged Joints:

1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
2. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

J. Pressure-Sealed Joints: Join copper tube and copper and copper-alloy fittings with tools recommended by fitting manufacturer.

K. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

L. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Apply primer and join according to ASME B31.9 and ASTM D 2672 for solvent-cemented joints.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or Type 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch-minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 30 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 36 inches with 3/8-inch rod.
3. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
4. NPS 4 and NPS 5: 48 inches with 1/2-inch rod.
5. NPS 6 and NPS 8: 54 inches with 5/8-inch rod.

L. Install supports for vertical PVC piping every 48 inches.

3.5 IDENTIFICATION

A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   1. Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

3.6 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of vacuum piping in nonmedical laboratory facilities and to prepare test and inspection reports.

B. Tests and Inspections:

   1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

      a. Test Pressure for Copper Tubing: 100 psig.
      b. Test Pressure for PVC Piping: 50 psig.

   2. Repair leaks and retest until no leaks exist.
   3. Inspect filters for proper operation.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.7 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.8 PIPING SCHEDULE

A. Connect new copper tubing to existing copper tubing with memory-metal couplings.

B. Connect PVC pipe to copper tube with transition fittings.

C. Flanges may be used where connection to flanged equipment is required.

D. Laboratory Low-Vacuum Piping: Use the following piping materials for each size range:

1. NPS 4 and Smaller: Copper medical gas tube, wrought-copper fittings, and brazed joints.
2. All Sizes: Extruded-tee fittings and brazed joints may be used instead of standard tee fittings.

E. Laboratory High-Vacuum Piping: Use the following piping materials for each size range:

1. NPS 4 and Smaller: Copper medical gas tube, wrought-copper fittings, and brazed joints.
2. All Sizes: Extruded-tee fittings and brazed joints may be used instead of standard tee fittings.

3.9 VALVE SCHEDULE

A. Shutoff Valves:

1. Copper Tubing: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
2. PVC Piping:

   a. NPS 4 and Smaller: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
   b. NPS 5 and Larger: PVC butterfly valve.

B. Zone Valves: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION 226213

SECTION 226313 - GAS PIPING FOR LABORATORY FACILITIES

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. Helium piping.
   2. Nitrogen piping.
   3. Argon piping.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Material Certificates: Signed by Installer certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.

C. Brazing certificates.

D. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For specialty gas piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

1.8 PROJECT CONDITIONS

A. Interruption of Existing Laboratory Gas Service(s): Do not interrupt laboratory gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of laboratory gas service(s).
2. Do not proceed with interruption of laboratory gas service(s) without Owner's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Helium, contractor to confirm operating pressure.

B. Nitrogen, contractor to confirm operating pressure.

C. Argon, contractor to confirm operating pressure.

2.2 PIPES, TUBES, AND FITTINGS

A. Comply with NFPA 99 for medical gas piping materials.

B. Copper Medical Gas Tube: ASTM B 819, Type K or Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service; or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

F. Shape-Memory-Metal Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Aerofit, Inc.
   b. Smart Tap; Smart Technology, Inc.

2. Description: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

G. PVC Pipe: ASTM D 1785, Schedule 40.

H. PVC Fittings: ASTM D 2466, Schedule 40; socket type.

I. Stainless steel Pipe and Fittings: Electro polished (clean grade) stainless steel.

2.3 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

C. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

2.4 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Healthcare Products Inc.
   b. Amico Corporation.
   c. Apollo Valves; Conbraco Industries, Inc.
   d. BeaconMedaes.
   e. Marwin Valve; Richards Industries.
   f. NIBCO INC.
   g. Ohio Medical Corporation.
   h. Tri-Tech Medical.

2. Standard: MSS SP-110.
3. Description: Three-piece body, brass or bronze.

4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
7. Handle: Lever.
8. Stem: Blowout proof with PTFE or TFE seal.
9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions and manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Healthcare Products Inc.
   b. Amico Corporation.
   c. Apollo Valves; Conbraco Industries, Inc.
   d. BeaconMedaes.
   e. Ohio Medical Corporation.
   f. Tri-Tech Medical.

2. Description: In-line pattern, bronze.
3. Pressure Rating: 300 psig minimum.
4. Operation: Spring loaded.
5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Safety Valves:

1. Bronze body.
2. ASME-construction, poppet, pressure-relief type.
3. Settings to match system requirements.

2.5 NITROGEN

A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Comply with NFPA 99 for installation of medical gas piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and for branch connections.

K. Install gas piping to gas service connections specified in this Section, to gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring gas service. Refer to project drawings for equipment requiring gas connections.

L. Install gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

M. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

N. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 VALVE INSTALLATION

A. Install shutoff valve at each connection to gas laboratory and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.

3.3 JOINT CONSTRUCTION

A. Ream ends of PVC pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

F. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Apply primer and join according to ASME B31.9 and ASTM D 2672 for solvent-cemented joints.

3.4 GAS SERVICE COMPONENT INSTALLATION

A. Assemble patient-service console with service connections. Install with supplies concealed in walls. Attach console box or mounting bracket to substrate.

B. Install nitrogen pressure-control panels in walls. Attach to substrate.

C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

D. Assemble ceiling-hose assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or Type 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feetor Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch-minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4: 60 incheswith 3/8-inchrod.
2. NPS 3/8 and NPS 1/2: 72 incheswith 3/8-inchrod.
3. NPS 3/4: 84 incheswith 3/8-inchrod.
4. NPS 1: 96 incheswith 3/8-inchrod.
5. NPS 1-1/4: 108 incheswith 3/8-inchrod.
6. NPS 1-1/2: 10 feetwith 3/8-inchrod.
7. NPS 2: 11 feetwith 3/8-inchrod.
8. NPS 2-1/2: 13 feetwith 1/2-inchrod.
9. NPS 3: 14 feetwith 1/2-inchrod.
10. NPS 3-1/2: 15 feetwith 1/2-inchrod.
11. NPS 4: 16 feetwith 1/2-inchrod.
12. NPS 5: 18 feetwith 1/2-inchrod.

13. NPS 6: 20 feetwith 5/8-inchrod.
14. NPS 8: 23 feetwith 3/4-inchrod.

J. Install supports for vertical copper tubing every 10 feet.

3.6 IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   1. Helium: White letters on brown background.
   2. Nitrogen: White letters on black background.
   3. Argon: White letters on black background.

3.7 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

   1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
   2. Repair leaks and retest until no leaks exist.
   3. Inspect specialty gas regulators for proper operation.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

D. Prepare test and inspection reports.

3.8 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.9 PIPING SCHEDULE

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Gas Piping except Nitrogen Piping Larger Than NPS 3and Operating at More Than 185 psig: Type L, copper tube; wrought-copper fittings; and brazed joints.

C. Nitrogen Piping Larger Than NPS 3and Operating at More Than 185 psig: Type K, copper tube; wrought-copper fittings; and brazed joints.

D. Argon Gas Piping except Specialty Gas Larger Than NPS 3and Operating at More Than 185 psig: Stainless steel piping and fittings.

E. Specialty Gas Piping Larger Than NPS 3 and Operating at More Than 185 psig: Type K, copper tube; wrought-copper fittings; and brazed joints.

F. Protective Conduit: PVC pipe, PVC fittings, and solvent-cemented joints.

3.10 VALVE SCHEDULE

A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

B. Zone Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION 226313

SECTION 226600 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY FACILITIES

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. Single-wall piping.
2. Piping specialties.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.

1.4 PERFORMANCE REQUIREMENTS

A. Single-Wall Piping Pressure Rating: 10 feet head of water.

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 70, "National Electrical Code."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.

B. Do not store plastic pipe or fittings in direct sunlight.

C. Protect pipe, fittings, and seals from dirt and damage.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Chemical-Waste Service: Do not interrupt chemical-waste service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary chemical-waste service according to requirements indicated:

1. Notify Owner no fewer thanseven days in advance of proposed interruption of chemical-waste service.
2. Do not proceed with interruption of chemical-waste service without Owner's written permission.

1.10 PROJECT CONDITIONS

A. Interruption of Existing Laboratory chemical waste Service(s): Do not interrupt laboratory chemical waste service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of laboratory chemical waste service(s).
2. Do not proceed with interruption of laboratory chemical waste service(s) without Owner's written permission.

PART 2 - PRODUCTS

2.1 SINGLE-WALL PIPE AND FITTINGS

A. PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with fusion- and mechanical-joint ends.

1. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Georg Fischer Inc.
   b. IPEX USA LLC.
   c. Orion Fittings; a Watts Water Technologies company.
   d. Town & Country Plastics, Inc.
   e. Watts; a Watts Water Technologies company.
   f. Zurn Industries, LLC.

B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.2 JOINING MATERIALS

A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

2.3 PIPING SPECIALTIES

A. Corrosion-Resistant Traps:

1. Type: P-trap or drum trap.
2. Size: NPS 1-1/2 or NPS 2, as required to match connected piping.
3. PP: ASTM D 4101, with mechanical-joint pipe connections.
4.

B. PP Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Watts; a Watts Water Technologies company.
   b. Zurn Industries, LLC.

2. Body: With 5-6top diameter, with flashing flange and weep holes; and with flashing clamp and trap-primer connection.
3. Outlet: Bottom, to match connecting pipe, with NPS 2, NPS 3, NPS 4, or NPS 6 outlet as indicated.

C. Stainless-Steel Cleanouts:
1. Standard: ASME A112.3.1, ASTM A 666, Type 316L, stainless steel.
2. Aboveground Piping: Cleanout tee of size matching piping.
3. Underground and Underslab Piping: Floor access cleanout of size matching piping.

D. PP Sink Outlets:

1. Description: NPS 1-1/2, with clamping device, stopper, and 7-inch-high overflow fitting.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Chemical-Waste Piping Inside the Building:

1. Install piping next to equipment, accessories, and specialties to allow service and maintenance.
2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
3. Flanges may be used on aboveground piping unless otherwise indicated.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Verify final equipment locations for roughing-in.
11. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
12. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
13. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 PIPING SPECIALTY INSTALLATION

A. Embed floor drains in 4-inch minimum depth of concrete around bottom and sides. Fasten grates to drains if indicated.

B. Set floor drains with tops flush with pavement surface.

3.3 JOINT CONSTRUCTION

A. Chemical-Waste Piping Inside the Building:

1. Plastic-Piping Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
2. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe sizes in this article refer to aboveground, single-wall piping.

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.
2. Individual, Straight, Horizontal Piping Runs:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for installation of supports.

D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

E. Support vertical piping and tubing at base and at each floor.

F. Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch.

G. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 33 inches with 3/8-inch rod.
2. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8: 48 inches with 7/8-inch rod.

H. Install supports for vertical PP piping every 72 inches.

I. Support piping and tubing not listed above according to MSS SP-69.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make connections to existing piping so finished Work complies as nearly as practical with requirements specified for new Work.

C. Use commercially manufactured wye fittings for sewerage piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi Insert value.

D. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.

E. Install piping adjacent to equipment to allow service and maintenance.

3.6 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.7 FIELD QUALITY CONTROL

A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place and again at completion of Project.

1. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Hydrostatic Tests for Drainage Piping:

1) Allowable leakage is a maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
2) Close openings in system and fill with water.
3) Purge air and refill with water.
4) Disconnect water supply.
5) Test and inspect joints for leaks.

e. Air Tests for Drainage Piping: Comply with UNI-B-6.

2. Leaks and loss in test pressure constitute defects that must be repaired.
3. Submit separate reports for each test.

B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Chemical-waste piping will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.8 CLEANING

A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Clean piping by flushing with potable water.

3.9 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
   1.

B. Aboveground Chemical-Waste and Vent Piping: Use the following piping materials for each size range:

   1. NPS 1-1/2 to NPS 6: PP drainage piping and electrofusion or mechanical joints.

END OF SECTION 226600

SECTION 226700 - PROCESSED WATER SYSTEMS FOR LABORATORY FACILITIES

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 deionized-water piping.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure Ratings:
   1. Deionized-Water Piping: Contractor to confirm operating pressure.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For water piping, accessories, and components, from manufacturer.

   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. ASME Compliance: Comply with ASME B31.3, "Process Piping," for piping conveying fluid at a pressure of 15 psigor greater.

PART 2 - PRODUCTS

2.1 PLASTIC PIPE AND FITTINGS

A. PP Pipe and Fittings for Heat-Fusion Joints: Made from ASTM D 4101, PP resin.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Asahi/America.
b. Georg Fischer Inc.
c. IPEX USA LLC.
d. NIBCO INC.
e. Orion Fittings; a Watts Water Technologies company.
f. Town & Country Plastics, Inc.

2. Schedule 40, Pipe and Fittings: Pipe made to ASTM D 2447, Schedule 40 or SDR 11 dimensions; with socket- or butt-fusion fittings matching pipe dimensions.

2.2 TRANSITION FITTINGS

A. Transition Fittings: Couplings, flanges, or other manufactured fittings; same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 PP VALVES

A. PP Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Asahi/America.
b. Georg Fischer Inc.
c. IPEX USA LLC.
d. NIBCO INC.
e. Orion Fittings; a Watts Water Technologies company.
f. Plast-O-Matic Valves, Inc.
g. Thermoplastic Valves, Inc.

2. Description:

a. Standard: MSS SP-122.
b. Pressure Rating: 150 psig at 73 deg F.
c. Body Material: ASTM D 4101, PP resin.
d. Body Design: Union type.
e. End Connections: Detachable, butt or socket.
f. Ball: ASTM D 4101, PP resin.
g. Port: Full.
h. Seats: PTFE.
i. Stem: ASTM D 4101, PP resin.
j. Stem Seals: FKM-rubber O-rings.
k. Handle: Tee shaped.

B. PP Swing-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Asahi/America.
c. Hayward Flow Control.
d. Spears Manufacturing Company.
e. Thermoplastic Valves, Inc.

2. Description:

a. Pressure Rating: 150 psig at 73 deg F.
b. Body Material: ASTM D 4101, PP resin.
c. Body Design: Bolted-bonnet type.
d. End Connections: Flanged.
e. Shaft: ASTM D 4101, PP resin.
f. Disc and Arm: ASTM D 4101, PP resin.
g. Gasket and Seals: FKM rubber.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for removal of ceiling panel, and coordinate with other services occupying that space.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Install piping to permit valve servicing.

G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure ratings unless otherwise indicated.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. PP Piping Heat-Fusion Joints: Make according to ASTM D 2657.

C. Join dissimilar pipe materials with transition fittings compatible with pipe materials being joined.

3.3 VALVE INSTALLATION

A. Install sectional valves close to mains on each branch and riser serving equipment.

B. Install shutoff valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves of same size as the pipe or tube in which they are installed unless otherwise indicated.

E. Install plastic valves of the same material as the plastic pipe in which they are installed.

F. Install valves in horizontal piping with stem at or above center of pipe.

G. Install valves in position to allow full movement of stem and lever handle.

H. Install swing-check valves in horizontal position with the hinge pin level.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install fiberglass pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Clamps for Vertical Piping: MSS Type 8 or Type 42.
6. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs, 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to minimum 3/8 inch.

E. Install padded hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.

2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 and NPS 3: 48 inches with 1/2-inch rod.

F. Install padded supports for vertical PP piping NPS 2-1/2 and larger every 120 inches and midstory for NPS 2 and smaller.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

C. Connect deionized-water piping to equipment and service outlets with unions or flanges.

3.6 IDENTIFICATION

A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. Test new piping, and parts of existing piping that have been altered, extended, or repaired, for leaks and defects.

1. Schedule tests and their inspections by Owner, with at least 24 hours' advance notice.
2. Do not cover piping or put into service before inspection and approval.
3. Test completed piping according to Owner. If Owner does not have published procedures, perform tests as follows:

   a. Hydrostatic Tests: Test piping at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 50 psig.

4. Replace leaking joints with new materials and retest until no leaks exist.
5. Submit separate reports for each test.

3.8 CLEANING

A. Use procedures prescribed by Owner or, if not prescribed, use procedures described below:

1. Before using, purge new piping and parts of existing piping that have been altered, extended, or repaired.
2. Clean piping by flushing with deionized water.

3.9 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping, and of same or compatible material, may be used in applications below.

B. Deionized-Water Piping: Use any of the following piping materials for each pipe size range:

1. NPS 3 and Smaller: PP pipe and fittings and heat-fusion joints.

3.10 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Install ball valves in piping NPS 2 and smaller.
2. Throttling Duty: Install ball valves in piping NPS 2 and smaller.

END OF SECTION 226700

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Motors 1/3 HP and smaller shall be 120 volts, single phase. Motors 1/2 HP and larger shall be 208, 230, or 460 volts, 3 phase. Motors shall be size and rating as indicated on the drawings. Motors that are an integral part of special equipment may vary from above to meet manufacturing standards.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. 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.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Shaft Grounding: Motors over 25HP shall be equipped with a conductive microfiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge electrical shaft currents within the motor and/or its bearings. AEGIS or equal. Grounding rings shall be installed in accordance with the manufacturer's recommendations. Application note: motors up to 100HP shall be provided with a minimum of one shaft grounding ring installed either on the drive end or non-drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or installed by a reputable motor shop with expertise in the proper

installation of devices. If the devices are not factory installed, a third party shall be engaged to test the installation to verify that no shaft currents are present.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

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.
2. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

C. 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 079200 "Joint Sealants."

D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6 : Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

2. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

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END OF SECTION 230517

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

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. Bronze ball valves.
2. Steel ball valves.
3. Iron ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.1 for power piping valves.
7. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece Bronze Ball Valves with Full Port and Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 STEEL BALL VALVES

A. Class 150 Steel Ball Valves with Full Port and Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 285 psig.
c. Body Design: Split body.
d. Body Material: Carbon steel, ASTM A 216, Type WCB.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

2.4 IRON BALL VALVES

A. Class 125 Iron Ball Valves:
1. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 200 psig.
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

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 valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG ([**104 kPa**]) OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller: Two piece, full port, bronze with stainless-steel trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron ball valves.

a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.

2. Class 150 steel ball valves.

3.5 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller: Two piece, full port, bronze with stainless-steel trim.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron ball valves.

a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.

2. Class 300 steel ball valves.

END OF SECTION 230523.12

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
3. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC 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, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Clevis
   2. Fee and Mason
   3. Anvil
   4. PDH Manufacturing, Inc,.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cooper B-Line, Inc.; a division of Cooper Industries.
   b. Unistrut; an Atkore International company.

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

2.5 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Piping: 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 and vapor barrier.

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.

2.6 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 anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Cast-in-place anchor system: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating. Anchor shall have a protective sleeve, steel flange with predrilled additional fastening holes and placement spring for attachment to metal deck. Anchor is to be secured by clamping the deck between the steel flange and the protective plastic sleeve. Anchor shall bear the diameter and manufacturer name on its hexagon head. Anchor shall be similar to HCI-MD as supplied by Hilti.

2.7 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. 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 for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. 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.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS 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. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Pipe-riser resilient supports.
5. Resilient pipe guides.
6. Spring hangers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.

3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Smooth, Ribbed, or Waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.

    a. Surface Pattern: Smooth, Ribbed, or Waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:
1. Mounting Plates:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:
1. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

    a. Housing: Cast-ductile iron or welded steel.
    b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.5 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. 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: White.
3. Background Color: Black.
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.
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-quarters the size of principal lettering.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping .

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: See label schedule in Part 3.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain 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. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. 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.

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

   1. Condenser-Water Piping: White letters on a safety-green background.
   2. Refrigerant Piping: White letters on a safety-purple background.
   3. Above grade natural gas piping: Black letters on a safety-yellow background.
   4. Condensate Drain Piping: White letters on a safety-green background.

3.5 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

   1. Blue: For cold-air supply ducts.
   2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Condenser Water: 1-1/2 inches, round.
   b. Refrigerant: 1-1/2 inches, round.
   c. Gas: 1-1/2 inches, round.

2. Valve-Tag Colors:

   a. Potable and Other Water: White letters on a safety-green background.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 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. Balancing Air Systems:

   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Balancing steam systems.

3. Testing, Adjusting, and Balancing Equipment:

   a. Motors.
   b. Condensing units.
   c. Heat-transfer Coils.
   d. Laboratory fume hoods.
   e. Laboratory pressure differentials.

4. Duct leakage tests.
5. Control system verification.
6. Tolerances.
7. Reporting.

1.3 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. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB specialist and certified by AABC or NEBB 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."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

J. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine system pumps to ensure absence of entrained air in the suction piping.

M. Examine operating safety interlocks and controls on HVAC equipment.

N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

   a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
   b. Duct systems are complete with terminals installed.
   c. Volume, smoke, and fire dampers are open and functional.
   d. Clean filters are installed.
   e. Fans are operating, free of vibration, and rotating in correct direction.
   f. Variable-frequency controllers' startup is complete and safeties are verified.
   g. Automatic temperature-control systems are operational.
   h. Ceilings are installed.
   i. Windows and doors are installed.
   j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

   a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
   b. Piping is complete with terminals installed.
   c. Water treatment is complete.
   d. Systems are flushed, filled, and air purged.
   e. Strainers are pulled and cleaned.

f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation" and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. 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.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Where duct conditions allow, measure airflow by 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 equipment manufacturer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

D. Check settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.7 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.

3.8 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Dry-bulb temperature of entering and leaving air.
3. 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 steam coil:

1. Dry-bulb temperature of entering and leaving air.

2. Relative humidity of entering and leaving air.

3. Airflow.
4. Inlet steam pressure.

D. 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.

3.10 PROCEDURES FOR LABORATORY FUME HOODS

A. Test unit to ensure that the equipment is operational and conforms to requirements as presented in contract documents. Field tests for fume hood operation and performance shall meet the requirements of ACGIH-2092S, ANSI Z9.5, ASHRAE 110, and SEFA 1-2.

B. Confirm air velocity at fume hood opening is at scheduled setpoint.

3.11 PROCEDURES FOR LABORATORY PRESSURE DIFFERENTIALS

A. Test pressure differentials between laboratory and adjacent spaces to confirm negative and/or positive pressure as indicated on drawings.

3.12 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.13 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.

8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.14 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Laboratory fume hood face velocity: Plus 10 percent, minus 0 percent.
4. Laboratory pressure differential: negative space, pressure shall be plus 0 percent, minus 10 percent; positive space, pressure shall be plus 10 percent, minus 0 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.

g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.

g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.

d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. 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.

I. 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.

J. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft..
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.

k. Barometric pressure in psig.

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. Instrument Calibration Reports:

1. Report Data:

   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.17 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.

B. 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.
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, Architect may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

A. Test and balance shall be performed for existing fan powered mixing boxes with revised ductwork routings.

B. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

C. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors and outdoors.
2. Steam and steam condensate piping, outdoors.
3. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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 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.

1.6 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.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. 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 Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular 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.

G. 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. 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.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.

c. K-Flex USA.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Mon-Eco Industries, Inc.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Mon-Eco Industries, Inc.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Foster Brand; H. B. Fuller Construction Products.
b. Knauf Insulation.
c. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Knauf Insulation.
e. Mon-Eco Industries, Inc.
f. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. 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, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Childers Brand; H. B. Fuller Construction Products.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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."

2.6 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.

2.7 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. in., in a Leno weave, for pipe.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Foster Brand; H. B. Fuller Construction Products.
      b. Vimasco Corporation.

2.8 FIELD-APPLIED JACKETS

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

B. Metal Jacket:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. ITW Insulation Systems; Illinois Tool Works, Inc.
c. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Elastomeric Insulation Jacketing System for Outdoors: Outdoor elastomeric jacketing system and the elastomeric insulation shall be manufactured by the same manufacturer. Outdoor jacketing systems by a different manufacturer than the elastomeric insulation manufacturer will not be accepted. Provide elastomeric jacketing system consisting of a multi-ply laminate jacketing with PVC backing and aluminum foil coating with a transparent protective polyester film that is factory-adhered to an NBR/PVC-based closed cell, flexible elastomeric foam insulation.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division.
b. Compac Corporation.
c. Ideal Tape Co., Inc,; an American Biltrite company.
d. Knauf Insulation.
e. Venture Tape.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division.
b. Compac Corporation.
c. Ideal Tape Co., Inc,; an American Biltrite company.
d. Knauf Insulation.
e. Venture Tape.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

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

C. 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.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to

structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

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

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

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

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

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its

attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install 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.

E. Install elastomeric jacketing for outdoor applications per manufacturer's installation instructions.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.8 FIELD-APPLIED JACKET INSTALLATION

A. 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.

B. Where elastomeric jacketing is indicated, install jacketing per manufacturer's installation instructions.

3.9 FINISHES

A. Do not field paint aluminum or stainless-steel jackets.

B. Do not field paint elastomeric jacketing systems unless required by the manufacturer.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 3/4 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3/4 inch thick.

B. Refrigerant Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 3/4 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3/4 inch thick.

B. Steam and Steam Condensate, 350 Deg F and Below:

1. All Pipe Sizes: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 3 inches thick.

C. Refrigerant Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inches thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

B. All exposed outdoor piping:

1. Aluminum or stainless steel: 0.016 inch thick.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:

1. Energy supply systems, including gas supply.
2. Heat generation systems, including furnaces.
3. Cooling generation systems, including direct-expansion systems.
4. Distribution systems, including air distribution (heating and cooling) systems, steam distribution systems, and air-handling units.
5. Terminal and packaged units, including electric heating packaged units and split system indoor units.
6. Controls and instrumentation, including BAS.
7. Systems testing and balancing verification, including supply-air systems, return-air systems, exhaust-air systems.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital controls.

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.

E. TAB: Testing, adjusting, and balancing.

F. ASHRAE: American Society Heating, Refrigerating, and Air-Conditioning Engineers

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.

B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:

1. Vibration controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Steam and condensate piping and accessories.
4. Refrigerant piping.
5. Metal ducts and accessories.
6. Fans.
7. Particulate air filtration.
8. Air-handling units with direct expansion coils and gas-fired heat exchangers.
9. Split system indoor units.
10. Computer-room air conditioners.
11. Laboratory fume hoods.
12. Electric duct heaters.

1.5 QUALITY ASSURANCE

A. All mechanical equipment (including domestic water recirculation) shall be commissioned per ASHRAE Standard 0 by an ASHRAE certified Commissioning Agent (CPMPC).

B. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

C. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and

application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.

2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. One of the following:

    a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.

b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
c. Owner retains the right to waive NEBB or AABC Certification.

D. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

a. Equipment/instrument identification number.
b. Planned commissioning application or use.
c. Manufacturer, make, model, and serial number.
d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:

a. Capable of testing and measuring performance within the specified acceptance criteria.
b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

E. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

1) Instrument or tool identification number.
2) Equipment schedule designation of equipment for which the instrument or tool is required.
3) Manufacturer, make, model, and serial number.
4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.

c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Mechanical and controls contractors shall be required to participate in commissioning process and shall remain on site until HVAC system is accepted by the Owner subsequent to commissioning.

B. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.

C. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

D. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

E. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

F. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

G. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

H. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.

1. Contributors to the development of construction checklists shall include, but are not limited to, the following:

a. HVAC&R systems and equipment installers.
b. TAB technicians.
c. HVAC&R instrumentation and controls installers.

I. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

J. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

K. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

L. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

M. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

N. Provide technicians, instrumentation, tools, and equipment to complete and document the following:

1. Performance tests.
2. Demonstration of a sample of performance tests.
3. Commissioning tests.
4. Commissioning test demonstrations.

3.2 COMMISSIONING PLAN

A. Submit the commissioning plan no later than 14 days prior to the start of construction. Identify the commissioning and testing standards and outline the overall commissioning process, schedule, and documentation requirements.

B. Contents

1. List of all equipment to be commissioned
2. Basis of design
3. Commissioning scope
4. Systems to be commissioned

5. Examples and descriptions of pre-functional and functional performance test checklists
6. Schedule for commissioning
7. Description of training requirements
8. Description of the commissioning report

3.3 PRE-FUNCTIONAL TESTS AND CHECKLISTS

A. The pre-functional checklists must include items for physical inspection or testing that demonstrate that installation and start-up of equipment and systems is complete.

B. Complete one pre-functional checklist for each individual item of equipment or system for each system required to be commissioned including, but not limited to, ductwork, piping, equipment, fixtures, and controls. Acceptance of each pre-functional checklist item indicates that item conforms to the construction contract and accepted design requirements. Submit the completed and initialed pre-functional checklists no later than 7 calendar days after completion of inspection of all checklist items for each system.

3.4 TAB COMMISSIONING TESTS

A. TAB Verification:

1. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
3. Scope: HVAC&R air systems and hydronic piping systems.
4. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
5. Conditions of the Test:

    a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
    b. Systems operating in full heating mode with minimum outside-air volume.
    c. Systems operating in full cooling mode with minimum outside-air volume.
    d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

6. Acceptance Criteria:

    a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.5 FUNCTIONAL PERFORMANCE TESTS AND CHECKLISTS

A. Functional performance test checklists must include procedures that explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract. Include the following sections and details appropriate to the systems being tested in the functional performance test checklists:

1. Notable system features including information about such attributes as system sizing and controls to facilitate understanding of system operation
2. Conclusions and recommendations based on control system features, point-to-point, actuator, and system operation observations. Conclusions must clearly indicate if system does not perform in accordance with contract requirements. Recommendation must clearly indicate that the system should or should not be accepted by the owner.
3. Test conditions including date, beginning and ending time, and beginning and ending ambient conditions.
4. Identification of the equipment involved.
5. As-found condition of the system operation.
6. System operation observations for system-based tests demonstrating each control algorithm, operation mode, and alarm condition resulting from control point manipulation. System operation observations must contain the following (as a minimum):

    a. As-found conditions prior to control point manipulation
    b. Clear list of test items
    c. Control algorithm
    d. Intended test procedure following each segmented control algorithm identifying control point required to be manipulated to initiate system response
    e. Expected system response
    f. Pass or fail for each test item

B. Abort functional performance tests when any system deficiency prevents the successful completion of the test.

C. Prior to testing operating modes, sequences of operation, interlocks, and safeties, complete control point-to-point observations, test sensor calibrations, and test actuator commands. Prior to system testing, complete control system feature, point-to-point, and actuator observation.

D. Seasonal tests

1. Perform initial functional performance tests as soon as all contract work is completed, regardless of the season. Develop and implement means of artificial loading to demonstrate, to a reasonable level of confidence, the ability of the HVAC systems to handle peak seasonal loads.

2. In addition to the initial functional performance tests, perform functional performance tests of HVAC systems under full-load conditions during peak heating and cooling seasons during outdoor air condition design extremes. Schedule seasonal functional performance tests with the Owner.

3.6 COMMISSIONING REPORT

A. Following the completion of the functional performance tests, with the exception of seasonal tests, prepare the commissioning report

1. Include an executive summary describing the overall commissioning process, the results of the commissioning process, any outstanding deficiencies and recommended resolutions, and any seasonal testing that must be scheduled for a later date. Indicate, in the executive summary, whether the systems meet the requirements of the construction contract.
2. Detail any deficiencies discovered during the commissioning process and the corrective actions taken in the report. Include the completed pre-functional checklists, functional performance test checklists, commissioning plans, issues log, and the final TAB report.
3. Submit the commissioning report no later than 14 calendar days following commissioning team acceptance of all functional performance tests.

END OF SECTION 230800

SECTION 230900 - INSTRUMENTATION AND CONTROL 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. This Section includes control equipment for HVAC systems and components, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.

B. All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.

C. This project is an extension of the existing Metasys Extended Architecture facility management system that currently serves the owner. Any new system provided as part of this project shall be fully integrated into this existing system. The system provided on this project will utilize open protocols at all levels. The BACnet protocol shall be utilized at the network controller level and field controller level. The current existing Application Data Server must be able to view, monitor, control, program, and modify the new products provided under this section. All new field equipment controllers shall be programmed with Metasys Controller Configuration Tool software.

D. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.

E. If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. MS/TP: Master slave/token passing.

D. PC: Personal computer.

E. PID: Proportional plus integral plus derivative.

F. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1.
   2. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
      a. Water Temperature: Plus or minus 1 deg F .
      b. Water Flow: Plus or minus 5 percent of full scale.
      c. Water Pressure: Plus or minus 2 percent of full scale.
      d. Space Temperature: Plus or minus 1 deg F .
      e. Ducted Air Temperature: Plus or minus 1 deg F .
      f. Outside Air Temperature: Plus or minus 2 deg F .
      g. Dew Point Temperature: Plus or minus 3 deg F .
      h. Temperature Differential: Plus or minus 0.25 deg F .
      i. Relative Humidity: Plus or minus 5 percent.
      j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
      k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
      l. Airflow (Terminal): Plus or minus 10 percent of full scale.
      m. Air Pressure (Space): Plus or minus 0.01-inch wg .
      n. Air Pressure (Ducts): Plus or minus 0.1-inch wg .
      o. Electrical: Plus or minus 5 percent of reading.

1.5 SEQUENCE OF OPERATION

A. SEE PLANS FOR SEQUENCE OF OPERATION

1.6 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Written description of sequence of operation including schematic diagram.
    c. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. As-built system record drawings. Drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
2. Manufacturers product data sheets or catalog pages for all products including software .
3. System Operator's manuals .
4. Archive copy of all site-specific databases and sequences .
5. BMS network diagrams .
6. Interfaces to all third-party products and work by other trades .

7. Maintenance instructions and lists of spare parts for each type of control device.
8. Interconnection wiring diagrams with identified and numbered system components and devices.
9. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
10. Calibration records and list of set points.

1.7 QUALITY ASSURANCE

A. The Facility Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Facility Management Systems.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

D. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the BMS business as a licensed contractor in the state in which the project is located for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.

E. In order to ensure the availability of rapid response, the installer shall have a local facility within a 25-mile radius of the job site. Emergency service shall be available on a 24-hour, 7-day-a-week basis.

F. In order to ensure proper oversight, an employee with no less than 10 years of experience shall supervise the overall engineering, installation, programming and startup of the Facility Management System. This employee will be an engineer or project manager actively involved in the project.

G. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

H. The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system. See plans for specific requirements.

C. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system. See plans for specific requirements.

D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

E. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces. See plans for specific requirements.

F. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices. See plans for specific requirements.

G. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices. See plans for specific requirements.

1.10 WARRANTY

A. Equipment: The control system components shall be free from defects in material and workmanship under normal use and service. If within one year from the date of completion any control system equipment is found to be defective, it will be replaced, repaired or adjusted at the option of the control system installer free of charge. The control system installer is not responsible for the removal or reinstallation of any components that were originally installed by others, such as valves, dampers, wells, airflow stations, etc...

B. Installation: The control system shall be free from defects in installation workmanship for a period of one year from acceptance. This includes defective mounting, wiring, piping, adjustment, calibration, programming, startup and commissioning. The control system installer shall correct any defects in workmanship at no cost to the owner.

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. The owner reserves the right to reject any bid that does not meet the specifications.

2.2 CONTROL SYSTEM

A. Manufacturer/Installer:
   1.
   2. Johnson Controls, Inc.; Controls Group. (No substitutions)
   3. Engineered Systems and Energy Solutions.
   4. Automated Building Systems.

B. To the extent that the facility is provided with Metasys controls, the control system shall be an extension of the existing Johnson Controls Metasys Facility Management System. All new products provided under this section must be compatible with the existing system. The current Application Data Server must be able to view, monitor, control, program, and modify the new products provided under this section.

C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

D. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

E. Manufacturers\Installers not listed above but requesting pre-approval must submit to architect\engineer at minimum 10 days prior to bid date a formal request for approval to bid project. Pre-approval request should include product data being submitted for review, company qualifications including training certificates, resumes of all employees to be assigned to this project, and proof of ten (10) successful projects with references of similar size and complexity executed by the office or branch submitting a request for approval. Manufacturers\Installers seeking approval must provide a compliance review submittal with their pre-approval request. The compliance review will be a paragraph-by-paragraph review of the specifications with the following information, "Comply", "Deviation", or "Does Not Comply" marked for each specification section paragraph. For each and every deviation, provide a reason for the

deviation for owner's consideration with possible alternatives. Provide supporting documentation for the owner's review

2.3 DDC SYSTEM GENERAL

A. General Description

1.
2. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
3. The Building Management System shall consist of the following:
   a.
   b. Standalone Network Automation Engine(s)
   c. Field Equipment Controller(s)
   d. Input/Output Module(s)
   e. Local Display Device(s)
   f. Portable Operator's Terminal(s)
   g. Distributed User Interface(s)
   h. Network processing, data storage and communications equipment
   i. Other components required for a complete and working BMS
4.
5. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
6. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices. The System shall maintain all settings and overrides through a system reboot.

B. Network

1.
2. The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
3. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
4. The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
5. The control system shall incorporate a primary Tier 1 network. At the Contractor's option, the control system may also incorporate integrated secondary Tier 2 and tertiary Tier 3 networks.

6. The control system Network shall utilize an open architecture capable of all of the following:
   a.
   b. Utilizing standard Ethernet communications and operate at a minimum speed of 100 Mb/sec
   c. Connecting via BACnet communication protocol at the Tier 1 level in accordance with as per ANSI/ASHRAE Standard 135-2001.
   d. Connecting via BACnet MSTP communication protocol at the Tier 2 and Tier 3 level.
   e.
7. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
8. The FMS network shall support both copper and optical fiber communication media.

C. Power Fail / Auto Restart
   1.
   2. Provide for the automatic orderly and predefined shutdown of parts or all of the control system following total loss of power to parts or all of the control system.
   3. Provide for the automatic orderly and predefined startup of parts or all of the control system following total loss of power to those parts or all of the control system. Archive and annunciate time and details of restoration.
   4. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.
   5. Maintain the control system real-time clock operation during periods of power outage for a minimum of 72 hours.

D. Application Data Server (Existing)
   1.
   2. Where necessary, servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server. The existing Application Data Server will be upgraded to the latest software release version at the end of the project.

E. Local Operator User Interface
   1.
   2. Where indicated on plans the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.
   3. The Local Operator User Interface PCs (PCs) shall provide the primary means of communication with the control system and shall be used for operations, engineering, management, audit, reporting and other related functions.
   4. Each fixed PC shall, at minimum, consist of:

a.
b. PC processor with minimum 64-bit word structure.
c. Hard drive or equal high-speed data storage.
d. Removable high-speed data storage and export device(s).
e. Full ASCII keyboard and digital Mouse or equal pointing device.
f. Full color, flat screen display unit, minimum 24 inches.
g. Color printer.
h.

5. All fixed PCs shall operate independently and concurrently without interference and under individual user password protection.
6. PCs functionality shall be individually definable by software means such that PC may be designated for specific limited functions.
7. Local Operator User Interface PCs shall not require any special software to be purchased from the control system manufacturer. All actions required for the complete operator interface as described herein shall be accomplished through a common browser.
8. The exact same user interface shall be accessible from any type of personal computer or mobile device running any type of operating system (ex. iOS, Android, Windows).
9. The interface shall automatically adapt and optimize the information displayed to fit the screen size of the client device and shall also be touch friendly.
10. Plug-ins and special native app software (ex. Downloaded and installed from an app store) shall not be required to conduct daily operations of buildings and equipment

F. Operator Interface Application Components

1.
2. An integrated browser based client application shall be used as the user operator interface program.
3. The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.
4. All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
5. The user interface software shall provide help menus and instructions for each operation and/or application.
6. The system shall support customization of the user interface configuration and a home page display for each operator.
7. The system shall support user preferences in the following screen presentations:
   a.
   b. Alarm
   c. Trend
   d. Display
   e. Applications
   f.
8. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

9. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
   a.
   b. User access for selective information retrieval and control command execution
   c. Monitoring and reporting
   d. Alarm, non-normal, and return to normal condition annunciation
   e. Selective operator override and other control actions
   f. Information archiving, manipulation, formatting, display and reporting
   g. BMS internal performance supervision and diagnostics
   h. On-line access to user HELP menus
   i. On-line access to current BMS as-built records and documentation
   j. Means for the controlled re-programming, re-configuration of BMS operation and for the manipulation of BMS database information in compliance with the prevailing codes, approvals and regulations for individual BMS applications
10.
11. The user interface shall provide a single display of all activity related to a specific piece of equipment including user changes, discarded user changes, pending alarms, discarded alarms and acknowledged alarms.
12.
13. Provide the capability to view, command and modify large quantities of similar data in tailored summaries without the use of a secondary application, like a spreadsheet. These summaries shall be automatically generated or user defined. User defined summaries shall allow up to seven user defined columns describing attributes to be displayed including custom column labels. Up to 100 rows per summary shall be supported.
14.
15. The system shall support a list of application programs configured by the users that are called up by the following means:
   a.
   b. The Tools Menu
   c. Hyperlinks within the graphics displays
   d. Key sequences
16.
17. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

2.4 NETWORK AUTOMATION ENGINES (NAE)

A. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

B. Automation network – The NAE shall reside on the Tier 1 automation network and shall support a subnet of system controllers.

C. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI). All computers connected physically or virtually to the automation network shall have access to the web based UI.

1.
2. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
3. The web based user shall have the capability to access all system data through one NAE.
4. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
5. Systems that require the user to address more than one NAE to access all system information are not acceptable.
6. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
7. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
8. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
   a.
   b. Configuration
   c. Commissioning
   d. Data Archiving
   e. Monitoring
   f. Commanding
   g. System Diagnostics
   h.
9. Systems that require workstation software or modified web browsers are not acceptable.
10. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

D. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

E. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

F. Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real-time clock.

G. The NAE shall include troubleshooting LED indicators to identify operating conditions.

H. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
   1.
   2. USB port
   3. URS-232 serial data communication port
   4. RS-485 port
   5. Ethernet port

I. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

J. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
   1.
   2. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
   3. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

K. Certification – The NAE shall be listed by Underwriters Laboratories (UL).

L. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
   1.
   2. The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   3. The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

2.5 DDC SYSTEM CONTROLLERS

A. Field Equipment Controller (**FEC**)
   1.
   2. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
      a.
      b. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
      c. The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
      d. The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
      e.

3. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences.
4. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
5. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
6. The FEC shall include troubleshooting LED indicators to identify operating conditions.
7. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
8. The FEC shall support the following types of inputs and outputs:
   a.
   b. Universal Inputs - shall be configured to monitor any of the following:
      1)
      2) Analog Input, Voltage Mode
      3) Analog Input, Current Mode
      4) Analog Input, Resistive Mode
      5) Binary Input, Dry Contact Maintained Mode
      6) Binary Input, Pulse Counter Mode
      7)
   c. Binary Inputs - shall be configured to monitor either of the following:
      1)
      2) Dry Contact Maintained Mode
      3) Pulse Counter Mode
      4)
   d. Analog Outputs - shall be configured to output either of the following
      1)
      2) Analog Output, Voltage Mode
      3) Analog Output, current Mode
      4)
   e. Binary Outputs - shall output the following:
      1)
      2) 24 VAC Triac
      3)
   f. Configurable Outputs - shall be capable of the following:
      1)
      2) Analog Output, Voltage Mode
      3) Binary Output Mode
      4)
9. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
   a.
   b. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
   c. The FC Bus shall support communications between the FECs and the NAE.
   d. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.

e. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
f. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
g.

10. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
    a.
    b. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
    c. The SA Bus shall support a minimum of 10 devices per trunk.
    d. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
    e.
11. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
12. The FEC shall support, but not be limited to, the following:
    a.
    b. Hot water, chilled water/central plant applications
    c. Built-up air handling units for special applications
    d. Terminal units
    e. Special programs as required for systems control
13.
14. All FEC's serving systems other than terminal units (fan coil units, VAV boxes, unit ventilators, etc...) will have an integral local controller display to allow user adjustment of the system without logging on to the system or using a portable operator terminal. All local controller displays will have the following features:
    a.
    b. The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
    c. The Display shall allow the user to view monitored points without logging into the system.
    d. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
    e. The Display shall provide password protection with user adjustable password timeout.
    f. The Display shall be menu driven with separate paths for:
        1)
        2) Input/Output
        3) Parameter/Setpoint
        4) Overrides
    g. The Display shall use easy-to-read English text messages.
    h. The Display shall allow the user to select the points to be shown and in what order.
    i. The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.
    j. The display shall be a minimum of 4 lines and a minimum of 20 characters per line.

k. FEC's not capable of having an integral local controller display will have hand-off-auto switches for digital outputs, potentiometer overrides for analog outputs, status lights for binary inputs, and digital gauges for analog inputs.

B. Input/Output Module **(IOM)**

1.
2. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
3. The IOM shall communicate with the FEC over the FC Bus or the SA Bus.
4. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
   a.
   b. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   c. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   d.
5. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
6. The IOM shall support the following types of inputs and outputs:
   a.
   b. Universal Inputs - shall be configured to monitor any of the following:
      1)
      2) Analog Input, Voltage Mode
      3) Analog Input, Current Mode
      4) Analog Input, Resistive Mode
      5) Binary Input, Dry Contact Maintained Mode
      6) Binary Input, Pulse Counter Mode
      7)
   c. Binary Inputs - shall be configured to monitor either of the following:
      1)
      2) Dry Contact Maintained Mode
      3) Pulse Counter Mode
      4)

d. Analog Outputs - shall be configured to output either of the following
   1)
   2) Analog Output, Voltage Mode
   3) Analog Output, current Mode
   4)
e. Binary Outputs - shall output the following:
   1)
   2) 24 VAC Triac
   3)
f. Configurable Outputs - shall be capable of the following:
   1)
   2) Analog Output, Voltage Mode
   3) Binary Output Mode
   4)

7. The IOM shall include troubleshooting LED indicators to identify operating conditions.

C. Terminal Equipment Controller **(TEC)**

1.
2. The TEC shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters or other similar equipment.
3. The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
   a.
   b. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   c. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   d.
4. The TEC shall support remote read/write and parameter adjustment from the web based User Interface through a Network Automation Engine.
5. The TEC shall include an intuitive User Interface providing plain text messages.
6. The TEC shall provide the flexibility to support any one of the following inputs:
   a.
   b. Integral Indoor Air Temperature Sensor
   c. Duct Mount Air Temperature Sensor
   d. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
   e. Two configurable binary inputs
   f.
7. The TEC shall provide the flexibility to support any one of the following outputs:
   a.
   b. Three Speed Fan Control
   c. Two On/Off
   d. Two Floating
   e. Two Proportional (0 to 10V)
   f.
8. The TEC shall provide the flexibility to adjust the following parameters:

a.
b. Adjustable Temporary Occupancy from 0 to 24 hours
c. Adjustable heating/cooling deadband from 2° F to 5° F
d. Adjustable heating/cooling cycles per hour from 4 to 8
e.

9. The TEC shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

D. VAV Modular Assembly **(VMA)**

1.
2. The VMA shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
3. The VMA shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
4.
   a. The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   b. The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   c.
5. The VMA shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
6. The VMA shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.
7. The VMA shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
8. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
9. The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
10. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
11. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
12. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
13. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

14. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
15. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
16. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
17. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
18. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance.
19. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
    a.
    b. Unreliable space temperature sensor
    c. Unreliable differential pressure sensor
    d. Starved box
    e. Actuator stall
    f. Insufficient cooling
    g. Insufficient heating
    h.
20. The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
21. Inputs:
    a.
    b. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
        1)
        2) 0-10 VDC Sensors
        3) 1000ohm RTDs
        4)
    c. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
    d. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
    e. Provide side loop application for humidity control.
    f.
22. Outputs
    a.
    b. Analog outputs shall provide the following control outputs:
        1)

2) 0-10 VDC
3)

c. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
d. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
e.

23. Application Configuration
24. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.
25. Sensor Support
    a.
    b. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
    c. The VMA shall support an LCD display room sensor.
    d. The VMA shall also support standard room sensors as defined by analog input requirements.
    e. The VMA shall support humidity sensors defined by the AI side loop.

E. Network Sensors (NS)
1.
2. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
3.
    a. Zone Temperature
    b. Zone Humidity
    c. Zone Setpoint
    d. Discharge Air Temperature
    e.
4. The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
5.
    a. The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
    b. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
    c.
6. The Network Zone Sensors shall include the following items:
    a.
    b. A backlit Liquid Crystal Display (LCD) to indicate the Temperature and Setpoint
    c. An LED to indicate the status of the Override feature
    d. A button to initiate a timed override command
    e.
7. The Network Discharge Air Sensors shall include the following:
    a.
    b. 4 inch or 8 inch duct insertion probe
    c. 10 foot pigtail lead
    d. Dip Switches for programmable address selection

F. Wireless Field Bus System

1. The System shall have the ability to employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for BACnet devices at multiple system levels. This includes communications from FEC and VMA field controllers to sensors and from engines to these field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.
2. The Wireless Field Bus Coordinator shall provide a wireless interface between supported field controllers and an NAE supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a Coordinator for initiation and formation of the network
   a.
   b. The coordinator shall use direct sequence spread spectrum RF technology.
   c. The coordinator shall operate on the 2.4 GHZ ISM Band.
   d. The coordinator shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
   e. The coordinator shall be FCC compliant to CFR Part 15 subpart B Class A.
   f. The coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
   g. The coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.
   h.
3. The Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VAV Modular Assembly to provide a wireless interface to supervisory engines, via the Coordinator, and associated Wireless Mesh Room Temperature Sensors. .
   a.
   b. The router shall use direct sequence spread spectrum RF technology.
   c. The router shall operate on the 2.4 GHZ ISM Band.
   d. The router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
   e. The router shall be FCC compliant to CFR Part 15 subpart B Class A.
   f. The router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
   g. The router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.
   h.
4. The Wireless Room Temperature Sensors shall sense and transmit room temperatures, room set point, room occupancy notification low battery condition to an associated router.
   a.
   b. The sensors shall use direct sequence spread spectrum RF technology.
   c. The sensors shall operate on the 2.4 GHZ ISM Band.
   d. The sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
   e. The sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
   f. Wireless sensors shall be provided with display of room temperature, signal strength, fan mode, occupancy and network status as required by application and indicated on plans or in schedules.

2.6 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. RTDs and Transmitters:
   1.
   2. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
   3. Averaging Elements in Ducts: 17 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
   4. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
   5. Room Sensor Cover Construction: Manufacturer's standard locking covers.
      a.
      b. Exposed setpoint adjustment.
      c. Override button..
      d. LCD Display.
      e. Color: White.
      f.
   6. Room sensor accessories include the following:
      a.
      b. Insulating Bases: For sensors located on exterior walls.
      c. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base. Locate where shown on the plans.
      d. Adjusting Key: As required for calibration and cover screws.
      e.
   7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
   8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. Humidity Sensors: Bulk polymer sensor element.
   1.
   2. Accuracy: 3 percent full range with linear output.
   3. Room Sensor Range: 20 to 80 percent relative humidity.
   4. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
   5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg .

D. Pressure Transmitters/Transducers:
   1.
   2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
      a.
      b. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.

c. Output: 4 to 20 mA. or 0 to 10 VDC
d. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
e. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).
f.

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA or 0 to 10 VDC.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA or 0 to 10 VDC.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

2.7 STATUS SENSORS

A. Status Inputs for Fans, Pumps, and Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

B. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

C. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

D. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

E. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.8 GAS DETECTION EQUIPMENT

A. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C).

B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA or 0 to 10 VDC output;, for wall mounting.

C. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA 0 to 10 VDC output; for wall mounting.

D. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

E. Refrigerant Monitor: Multi-zone refrigerant monitor using a non-dispersive infrared source and sample draw system, Accuracy of ±10 ppm from 0 to 100 ppm, ±10% of reading from 100 to 10,000 ppm. Provide communication card to allow refrigerant monitor to communicate with the Metasys building management system.

2.9 AIR FLOW MONITORING

A. Provide airflow measuring stations where shown on the plans.

B. Each measurement device shall consist of one or more sensor probe assemblies and a single microprocessor-based transmitter.

C. Sensor Probe Assemblies

1.

2. Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate.

3. Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of ±2% of reading over the entire operating airflow range. Each sensor assembly shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
4. The operating temperature range for the sensor probe assembly shall be -20F to 160F. The operating humidity range for the sensor probe assembly shall be 0-99%RH (non-condensing).
5. Each sensor assembly shall not require matching to the transmitter in the field.

D. Duct Sensor Probe Assemblies
1.
2. Sensor housings shall be mounted in an extruded aluminum tube probe assembly.
3. The number of sensor housings provided at each location shall be determined by the manufacturer based upon the requirements of the application to provide an airflow rate measurement accuracy of ±3%.
4. Probe assembly mounting brackets shall be constructed of stainless steel. The probe assemblies shall be insertion mounted through the side or top of the duct.
5. The maximum operating airflow range shall be 0-5000FPM.

E. Fan Inlet Sensor Probe Assemblies
1.
2. Sensor housings shall be mounted on stainless steel blocks.
3. Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
4. Mounting feet shall be constructed of stainless steel.
5. The maximum operating airflow range shall be 0-10,000FPM.

F. Transmitters
1.
2. The transmitter shall operate on 24VAC.
3. The operating temperature range for the transmitter shall be -20F to 120F. The transmitter shall be protected from weather and water.
4. The transmitter shall provide a field selectable linear analog output signal of either 0-10VDC or 4-20mA (4-wire).

2.10 WATER FLOW MONITORING

A. Provide water flow meters where shown on the plans.

B. Provide insertion electromagnetic flow meters with 0-10VDC, 0-5VDC or 4-20mA output.

C. Liquid temperature range shall be: 15° to 250° F

D. Ambient temperature range of -20F to 150F.

E. Wetted metal components: 316 stainless steel

F. Sensor head: Polystyrene

G. Weathertight NEMA 4 aluminum enclosure

H. Flow meter shall be wet-calibrated against standards directly traceable to NIST. Certification of calibration shall be provided.

2.11 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
   1. Label switches "FAN ON-OFF" .
   2. Mount on single electric switch box.

B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
   1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
   2. Selector Switch: Integral, manual on-off-auto.

C. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

D. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
   1. Bulb Length: Minimum 20 feet (6 m).
   2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

2.12 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1.
   2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).

4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:
a.
b. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
c. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
d. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
e. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
f. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
g. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
h.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 0- to 10-V dc or 4 to 20 mA.

2.13 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Hydronic system globe valves shall have the following characteristics:
1.

2. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
3. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
4. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
5. Sizing: **[5-psig (35-kPa)]** maximum pressure drop at design flow rate.
6. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
7. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 100 percent of total system (pump) head.

C. Steam system globe valves shall have the following characteristics:
   1.
   2. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
   3. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   4. Internal Construction: Replaceable plugs and stainless-steel seats.
   5. Sizing: As required for proper operation of equipment.
   6. Flow Characteristics: Modified linear characteristics.
   7. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.

D. Butterfly Valves: ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
   1.
   2. Body Style: Lug
   3. Disc Type: Aluminum bronze.
   4. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.

E. Ball Valves, 1/2 through 2 in:
   1.
   2. Ball Valves shall have forged brass bodies.
   3. Valves shall have available either Chrome Plated Brass Balls or 300 Series Stainless Steel Balls in all sizes.
   4. Valves shall have available either Nickel Plated Brass Stems or 300 Series Stainless Steel Stems with a blow-out proof stem design in all sizes.
   5. Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.
   6. Stem seals shall be double EPDM O-rings.
   7. Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure and shall be inserted against the casting of the valve.
   8. All ball valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F (95°C) fluid temperature.
   9. All ball valves with sweat end connections or press end connection shall be rated to 300 psig maximum static pressure at 203°F (95°C) fluid temperature
   10. All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
   11. Ball Valves with stainless steel balls and stems shall be rated for use with 15 psig saturated steam.
   12. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
   13. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
   14. Valves shall be maintenance free
   15. Valves shall be provided with a 5 year warranty.

16. Valves shall be rated for 200 psid closeoff pressure.
17. Valve actuators shall be UL-recognized or CSA-certified.
18. Sizing: [**5-psig (35-kPa)**] maximum pressure drop at design flow rate.

F. Ball Valves, 2-1/2 through 4 in. Flanged:
   1. Ball Valves shall have forged brass bodies with ASME Class 150 ductile iron flanges.
   2. Valves shall have 300 Series Stainless Steel Balls.
   3. Valves shall have 300 Series Stainless Steel Stems with a blow-out proof stem design.
   4. Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.
   5. Stem seals shall be double EPDM O-rings.
   6. Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure.
   7. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
   8. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
   9. All valves shall be rated for service with hot water, chilled water, 50% glycol solutions and rated for use with 25 psig saturated steam.
   10. Two-Way Valves shall be rated for 100 psid closeoff pressure and Three-Way Valves shall be rated for 50 psid closeoff pressure.
   11. Valves shall be maintenance free.
   12. Valves shall be provided with a 5 year warranty.
   13. Valve actuators shall be UL-recognized or CSA-certified.
   14. Sizing: [**5-psig (35-kPa)**] maximum pressure drop at design flow rate.

2.14 DAMPERS

A. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).
   1.
   2. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
   3. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
   4. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
   5. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 INSTALLATION

A. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

E. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

F. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. The entire control system shall be installed in a workmanlike manner in accordance with the manufacturer's wiring diagrams. The control system installer shall provide all wiring, conduit, outlet boxes, junction boxes, panels and similar devices necessary for a complete installation.

B. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

C. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Wiring in mechanical/electrical rooms and concealed spaces shall be in conduit.
   3. Exposed wiring shall only be allowed in concealed accessible locations and shall be plenum rated. Wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
8. All wiring shall be installed in accordance with local code requirements.

E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.

10. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
3. Control System Inputs and Outputs:
    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span.
4. Flow:
    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.
5. Pressure:
    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
6. Temperature:
    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span.
    b. Calibrate temperature switches to make or break contacts.
7. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
8. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
9. Provide diagnostic and test instruments for calibration and adjustment of system.
10. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits for this purpose.

3.6 TRAINING

A. The control system installer shall provide the following training services:

1.
2. One day on-site orientation consisting of a review of the project as-built drawings and O&M manuals, and a walk through of the facility to identify control panels and device locations. Include instruction on procedures for recovery from a system outage such as resetting of breakers or panels. Also include review of periodic maintenance and adjustment requirements.
3. One day on-site training to cover all sequences of operation and user/management functions of the operator interface. Include such topics as logging-on and off, alarm management, schedule management, data and setpoint display, command, override and adjustment, report generation, trend log set-up and analysis, password management, operator activity review, and system archive and database management.

END OF SECTION 230900

SECTION 231123 - FACILITY NATURAL-GAS PIPING

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. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Regulators: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Qualification Data: For qualified professional engineer.

D. Welding certificates.

E. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 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.

1.10 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. NotifyOwner] no fewer than seven days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

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. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

5. Mechanical Couplings:
   a. Steel flanges and tube with epoxy finish.
   b. Buna-nitrile seals.
   c. Steel bolts, washers, and nuts.
   d. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   e. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. 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 "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles 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. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded .
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.

4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

Comment [SG1]: Do we have any motorized gas valves? I don't think we do...

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. Service 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. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 100 psig.

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.
8. Maximum Inlet Pressure: 2 psig .

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Description:
      a. Standard: ASSE 1079.
      b. Pressure Rating: 125 psig minimum at 180 deg F.
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Description:
      a. Standard: ASSE 1079.
      b. Factory-fabricated, bolted, companion-flange assembly.
      c. Pressure Rating: 125 psig minimum at 180 deg F.
      d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Description:
      a. Nonconducting materials for field assembly of companion flanges.
      b. Pressure Rating: 150 psig.
      c. Gasket: Neoprene or phenolic.
      d. Bolt Sleeves: Phenolic or polyethylene.
      e. Washers: Phenolic with steel backing washers.

2.7 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping 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.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Refer to natural gas utility company for underground piping.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

D. Install fittings for changes in direction and branch connections.

E. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 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 indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. 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.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. 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. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

3. 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.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. 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.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "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.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. 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.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for 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.

3.10 PAINTING

A. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (semigloss).
d. Color: Gray, unless on roof shall be Yellow.

B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).
d. Color: Yellow.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 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.

3.12 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping NPS 2 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground natural-gas piping NPS 2 1/2 and larger shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping NPS 2 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

C. Aboveground, distribution piping NPS 2 1/2 and larger shall be the following:

1. Steel pipe with steel welding fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

C. Valves in branch piping for single appliance shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 231123

SECTION 232213 - STEAM AND CONDENSATE HEATING PIPING

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 pipe and fittings for LP HP steam and condensate piping:

B. Related Requirements:

1. Section 232216 "Steam and Condensate Piping Specialties" for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

1.3 ACTION SUBMITTALS

A. Product Data: For RTRP and RTRF and adhesive.

B. Shop drawings: Submit shop drawings showing piping routing for steam piping and condensate piping including all connections to equipment, as well as all steam piping accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to the following:

1. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. HP Steam Piping: 150 psig.
2. LP Steam Piping: 15 psig.
3. Condensate Piping: 15 psig at 250 deg F.
4. Makeup-Water Piping: 80 psig at 150 deg F.
5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.3 FIBERGLASS PIPE AND FITTINGS

A. RTRP: ASTM D 2996, Type 1, Grade 1, Class F, filament-wound pipe with tapered bell and spigot ends for adhesive joints.

B. RTRF: ASTM D 5685, Type 2 or Type 5, Grade 1, Class F, compression or spray-up/contact molded fittings of same material, pressure class, and joining method as pipe.

C. Flanges: ASTM D 4024, Type 1, Grade 1, full-face gaskets suitable for the service, minimum 1/8 inchthick, 60-70 durometer. ASTM A 307, Grade B, hex head bolts with washers.

D. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inchmaximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: , Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and RTRF with adhesive or flanged joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and RTRF with adhesive or flanged joints.

3.2 ANCILLARY PIPING APPLICATIONS

A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

B. Vacuum-Breaker Piping: Outlet, same as service where installed.

C. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4full port-ball valve, and short NPS 3/4threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4nipple and full port ball valve in blowdown connection of strainers NPS 2and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

U. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

W. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
2. Size drip legs same size as main. In steam mains NPS 6and larger, drip leg size can be reduced, but to no less than NPS 4.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 STEAM AND CONDENSATE PIPING SPECIALTIES INSTALLATION

A. Comply with requirements in Section 232216 "Steam and Condensate Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.5 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for installation of hangers and supports. Comply with requirements below for maximum spacing.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feetor longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

D. Install hangers for steel steam supply piping with the following maximum spacing:

1. NPS 3/4Maximum span, 9 feet.
2. NPS 1: Maximum span, 9 feet.
3. NPS 1-1/2: Maximum span, 12 feet.
4. NPS 2: Maximum span, 13 feet.
5. NPS 2-1/2: Maximum span, 14 feet.
6. NPS 3 and Larger: Maximum span, 15 feet.

E. Install hangers for steel steam condensate piping with the following maximum spacing:

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

G. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

3.6 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. 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.

D. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.8 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

E. Prepare test and inspection reports.

COT-232213

END OF SECTION 232213

SECTION 232216 - STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following piping specialties for LP and HP steam and condensate piping:

1. Strainers.
2. Flash tanks.
3. Safety valves.
4. Pressure-reducing valves.
5. Steam traps.
6. Thermostatic air vents and vacuum breakers.
7. Steam and condensate meters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pressure-reducing and safety valve.
2. Steam trap.
3. Air vent and vacuum breaker.
4. Flash tank.
5. Meter.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to the following:

1. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. HP Steam Piping: 150 psig.
2. LP Steam Piping: 15 psig.
3. Condensate Piping: 15 psig at 250 deg F.
4. Makeup-Water Piping: 80 psig at 150 deg F.
5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

B. Stop-Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. A.Y. McDonald Mfg. Co.
   b. Cincinnati Valve Company.
   c. Crane; Crane Energy Flow Solutions.
   d. Jenkins Valves.
   e. Lunkenheimer Valves.

2. Body and Bonnet: Malleable iron.
3. End Connections: Flanged.
4. Disc: Cylindrical with removable liner and machined seat.
5. Stem: Brass alloy.
6. Operator: Outside screw and yoke with cast-iron handwheel.

7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
8. Pressure Class: 250.

2.3 STRAINERS

A. 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 strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig working steam pressure.

B. Basket Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 250-psig working steam pressure.

2.4 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.5 SAFETY VALVES

A. Bronze or Brass Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Kunkle Valve.
   c. Spirax Sarco, Inc.
   d. Watts; a Watts Water Technologies company.

2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.

4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Kunkle Valve.
   c. Spirax Sarco, Inc.
   d. Watts; a Watts Water Technologies company.

2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6 PRESSURE-REDUCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong International, Inc.
2. Spence Engineering Company, Inc.
3. Spirax Sarco, Inc.

B. ASME labeled.

C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

D. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

E. Body: Cast iron.

F. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

G. Trim: Hardened stainless steel.

H. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

I. Gaskets: Non-asbestos materials.

J. Capacities and Characteristics:

1. Steam Flow Rate: 800 lb/hr.
2. Inlet Pressure: 150 psig.
3. Outlet Set Pressure: 50 psig.

2.7 STEAM TRAPS

A. Float and Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Hoffman Specialty.
   c. Spirax Sarco, Inc.
   d. Sterling.

2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

B. Inverted Bucket Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Hoffman Specialty.
   c. Spirax Sarco, Inc.
   d. Sterling.

2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.

9. Pressure Rating: 250 psig.

2.8 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Hoffman Specialty.
   c. Spirax Sarco, Inc.
   d. Sterling.

2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 300 psig.
7. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Armstrong International, Inc.
   b. Hoffman Specialty.
   c. Spirax Sarco, Inc.
   d. Sterling.

2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-Ring Seal: EPR.
6. Pressure Rating: 300 psig.
7. Maximum Temperature Rating: 350 deg F.

2.9 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Duraflex, Inc.

b. Flexicraft Industries.
c. Mason Industries, Inc.
d. Metraflex Company (The).

2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 PIPING INSTALLATION

A. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install valves according to Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

D. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

E. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown

connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

H. Flash Tank:

1. Pitch condensate piping down toward flash tank.
2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
3. Install thermostatic air vent at tank top.
4. Install safety valve at tank top.
5. Install full-port ball valve, and swing check valve on condensate outlet.
6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
7. Install pressure gage on low-pressure steam outlet according to Section 230519 "Meters and Gages for HVAC Piping."

3.3 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.4 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on both sides of pressure-reducing valves.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.

E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Section 230519 "Meters and Gages for HVAC Piping."

F. Install strainers upstream for pressure-reducing valve.

G. Install safety valve downstream from pressure-reducing valve station.

3.5 STEAM OR CONDENSATE METER INSTALLATION

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.

B. Provide data acquisition wiring. See Section 230923 "Direct Digital Control (DDC) System for HVAC"

3.6 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Install traps and control valves in accessible locations close to connected equipment.

B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

END OF SECTION 232216

SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO LLC.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

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.

2.4 DUCT LINER

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AP Armaflex by Armacell
   b. Duct Liner Gray by K-Flex.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

   a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel ; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.

5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers

and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    b. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Dedicated outdoor air unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.

3.7 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to split system evaporator units:

   a. Pressure Class: Positive 1-inch wg.
   b. Minimum SMACNA Seal Class: C.
   c. SMACNA Leakage Class for Rectangular: 24.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Dedicated Outdoor Air Units:

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:

1. Ducts Connected to split system evaporators:

   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: C.
   c. SMACNA Leakage Class for Rectangular: 24.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

   a. NOTE: Ducts connecting to existing exhaust air ductwork for laboratory shall match existing ductwork.

b. Pressure Class: Negative 2-inch wg.
c. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
d. SMACNA Leakage Class for Rectangular: 12.

E. SMACNA Leakage Class for Round and Flat Oval: 6Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

F. Liner (Refer to details):

1. Transfer Ducts: Fibrous glass, Type I Flexible or Type II Rigid, 1/2 inches thick.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Velocity 1000 fpm or Lower:

      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.

   b. Velocity 1000 to 1500 fpm:

      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

   c. Velocity 1500 fpm or Higher:

      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Manual volume dampers.
2. Fire dampers.
3. Smoke dampers.
4. Combination fire and smoke dampers.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

B. Related Requirements:

1. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
2. Section 283112 "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Manual volume damper installations.
b. Combination fire- and smoke-damper including sleeves; and duct-mounted access doors .

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: or G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. 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.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Greenheck.
b. Nailor Industries Inc.
c. Price Industries.
d. Ruskin Company.
e. Tuttle and Bailey.
f. Metal Aire.
g. Pottorff.
h. United Enertech.

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Frame: Hat-shaped, 0.05-inch- thick galvanized sheet steel.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel, 0.06 thick.

6. Blade Axles: Plated steel.
7. Bearings:

a. 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. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.

3. Price Industries.
4. Ruskin Company.
5. Tuttle and Bailey.
6. Metal Aire.
7. Pottorff.
8. United Enertech.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 2-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: See plans.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05 thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.024-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

K. Heat-Responsive Device: Replaceable link and switch package, factory installed, 165 deg F and 212 deg F rated.

2.5 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.
4. Ruskin Company.
5. United Enertech.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with interlocking, gusseted or mechanically attached corners and mounting flange.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch thick, galvanized sheet steel.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.0625-inch thick, galvanized sheet steel; length to suit wall or floor application.

I. Damper Motors: two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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 Section 230923 "Direct Digital Control (DDC) System for HVAC."
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: Damper motor voltage shall be 24V, unless otherwise noted. It is the mechanical contractor's responsibility to provide power (transformer(s), conductors, conduits, connections, etc.) to the smoke dampers. Refer to the electrical drawing(s) for location(s) of 120V circuit(s) available for mechanical controls and damper power. If not shown on the electrical drawings, connect to a 120V 15A or 20A "Spare" circuit breaker. The smoke damper(s) shall be powered from these circuit(s). The smoke dampers shall be signaled from the fire alarm panel.

K. Accessories:

1. Auxiliary switches for signaling fan control or position indication.
2.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Price Industries.
4. Ruskin Company.
5. Tuttle and Bailey.
6. Metal Aire.
7. Pottorff.
8. United Enertech.
9.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 2-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: See plans hours.

E. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded or interlocking, gusseted or mechanically attached corners and mounting flange.

F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

G. Heat-Responsive Device: resettable link and switch package, factory installed, rated.

H. Smoke Detector: Integral, factory wired for single-point connection.

I. Blades: Roll-formed, horizontal, interlocking or overlapping,0.034-inch- thick, galvanized sheet steel.

J. Leakage: Class I.

K. Rated pressure and velocity to exceed design airflow conditions.

L. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.

M. Master control panel for use in dynamic smoke-management systems.

N. Damper Motors: Modulating or two-position action.

O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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 Section 230923 "Direct Digital Control (DDC) System for HVAC."
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: Damper motor voltage shall be 24V, unless otherwise noted. It is the mechanical contractor's responsibility to provide power (transformer(s), conductors, conduits, connections, etc.) to the smoke dampers. Refer to the electrical drawing(s) for location(s) of 120V circuit(s) available for mechanical controls and damper power. If not shown on the electrical drawings, connect to a 120V 15A or 20A "Spare" circuit breaker. The smoke damper(s) shall be powered from these circuit(s). The smoke dampers shall be signaled from the fire alarm panel.

2.7 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Price Industries.
4. Ruskin Company.
5. Tuttle and Bailey.
6. Metal Aire.
7. Pottorff.
8. United Enertech.

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.

2.8 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Price Industries.
4. Ruskin Company.
5. Tuttle and Bailey.
6. Metal Aire.
7. Pottorff.
8. United Enertech.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. 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. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Price Industries.
4. Ruskin.
5. Tuttle and Bailey.
6. Pottorff.
7. United Enertech.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.

2.10 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. 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.

D. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.11 FLEXIBLE DUCTS

A. Noninsulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 100 to plus 435 deg F.
   a. Temperature Range: For connection to laboratory equipment exhausting from an oven, duct must be able to withstand up to 1,000 deg F.

2.12 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke and fire-smoke combination dampers according to UL listing.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. At drain pans and seals.
   2. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   3. 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.
   4. At each change in direction and at maximum 50-foot spacing.
   5. Upstream from turning vanes.
   6. Control devices requiring inspection.
   7. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:

   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
   3. Head and Hand Access: 18 by 10 inches.

4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

J. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. Install duct test holes where required for testing and balancing purposes.

M. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that 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 233300

SECTION 233423 - HVAC POWER VENTILATORS

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. Centrifugal roof ventilators.
   2. Centrifugal laboratory exhaust fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actua Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also 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.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705.

D. Centrifugal laboratory exhaust fans shall conform to ANSI/AMCA Standard 99 for spark resistance construction.

E. Centrifugal laboratory exhaust fans shall be vibration tested before shipping, as an assembly, in accordance with ANSI/AMCA Standard 204. Each assembled fan shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in three plains – horizontal, vertical, and axial. The maximum allowable fan vibration shall be less than 0.01 in /sec peak velocity; filter-in reading as measured at the fan RPM. This report shall be provided at no charge to the customer upon request.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

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 & Manufacturing Corp.
   2. Aerovent; a division of Twin City Fan Companies, Ltd.
   3. Greenheck Fan Corporation.
   4. Loren Cook Company.
   5. PennBarry, Division of Air System Components

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Accessories: (refer to schedule for required accessories)

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

E. 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. Provide curb adaptor for existing curb.
1. Overall Height: 12 inches.

F. Capacities and Characteristics:

2.2 Refer to project drawings. CENTRIFUGAL LABORATORY EXHAUST FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. Strobic Air

B. Design and selection
1. Performance rated at 0.075 lb/cubic feet air density.
2. Capable of accommodating static pressure and flow variations of +/- 15%.
3. Fan assembly designed for a minimum of 125-mph wind loading without the use of guy wires. Guy wires are not allowed.

C. Corrosion resistant coating
1. All fan and system components shall be corrosion resistance coated with a two part electrostatically applied and baked, sustainable coating system. Coating shall be manufacturer's standard color.
2. Coating shall be appropriate for the chemicals in use in the laboratory.
3. Coating shall be unaffected by UV.
4. Coating shall exceed 4,000 hr ASTM B117 salt spray test.

D. Fan housing and inlet
1. Housing shall be centrifugal involute scroll, allowing all drive components including motor to be serviced without contact of the contaminated airstream, and manufactured of welded steel.
2. A high velocity discharge nozzle shall be supplied by the fan manufacturer designed to efficiently handle an outlet velocity of up to 7,000 feet per minute. Discharge stack caps or hinged covers impeding exhaust flow shall not be permitted.
3. Integral housing drain for rainwater draining shall be provided.
4. Bolted access door shall be supplied for impeller inspection.
5. Fan assembly shall be AMCA type C spark resistance construction minimum.

E. Fan impeller
   1. Centrifugal, single width single inlet, backward inclined airfoil blad design with non-stall characteristics. Impeller shall be electronically balanced both statically and dynamically, meeting AMCA standards.
   2. Fan impeller shall be welded steel.

F. Bypass plenum is not required for constant volume system.

G. Fan motor and drive
   1. Motor shall be premium efficiency, standard NEMA frame, TEFC with 1.15 service factor.
   2. A factory-mounted NEMA 3R disconnect switch shall be provided for each fan.
   3. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.
   4. Belt drive configuration shall be AMCA arrangement 10.
   5. Drive belts and sheaves shall be sized for 200% of the fan operating bhp and shall be readily and easily accessible for service. Drive shall consist of a minimum of two belts.
   6. Fan shaft shall be turned and polished 1040 steel.
   7. Fan shaft bearings shall be air handling quality, ball or roller pillow block type and sized for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each fan class.
   8. Extended lube lines.
   9. Motor, coupling, and bearings shall be out of contaminated exhaust, capable of replacement without disassembling the fan and accessing hazardous and contaminated fan components.

H. Accessories
   1. Refer to schedule and project drawings

I. Airflow monitoring
   1. Flow monitoring station shall monitor the pressure difference between the fan inlet and smallest diameter of the inlet cone.
   2. Volumetric flow to be calculated from empirically derived formulas based on testing by the fan manufacturer.
   3. Flow monitoring system shall not use air restricting devices in the air stream.
   4. Provide fan-mounted electronics including pressure transmitter and LCD digital readout for each fan. Signal shall be provided to building automation system.

J. Warranty
   1. Manufacturer's standard 12 month warranty.
   2. Motor shall be warranted for a period of one year.

K. Capacities and Characteristics:

   1. Refer to schedule and project drawings

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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.

B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to 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. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CENTRIFIGUAL LABORATORY EXHAUST FAN INSTALLATION

A. Fans shall be mounted on vibration isolators, furnished by the fan manufacturer.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

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.
5.
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.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Lubricate bearings.

END OF SECTION 233423

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

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 factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Prepare the following by or under the supervision of a qualified professional engineer:

    a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
    b. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

B. Startup service reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Five years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: 25 years, non-prorated from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers (All manufacturers listed below are required to meet the requirements listed in the schedule and specifications. Manufacturer's listed below are not automatically approved and will be rejected during the submittal process if they do not meet the requirements listed in the schedule and specifications.):

1. Aaon.
2. Addison.
3. Carrier.
4. Greenheck.
5. Trane.
6. Valent.
7. York.

2.2 PERFORMANCE REQUIREMENTS

A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."

B. Cabinet Thermal Performance:

1. Maximum Overall U-Value: 0.077 Btu/h x sq. ft. x deg F, minimum.
2. Provide thermal breaks.
3. Include effects of metal-to-metal contact and thermal bridges in the calculations.

C. Cabinet Surface Condensation:

1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.

D. Maximum Cabinet Leakage: 1 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.

E. Cabinet Deflection Performance:

1. Walls and roof deflection shall be within 1/240 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
2. Floor deflections shall be within 1/240 of the span considering the worst-case condition caused by the following:

   a. Service personnel.
   b. Internal components.
   c. Design working pressure defined for the walls and roof.

F. 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.

G. Capacities and Characteristics: See Schedule on Drawings.

2.3 CABINET

A. Construction: double wall with thermal breaks.

B. Exterior Casing Material: G90 Galvanized steel with paint finish.

C. Interior Casing Material: G90 Galvanized steel.

D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.

E. Base Rails: G90 Galvanized-steel rails for mounting on roof curb or pad as indicated.

F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.

G. Roof: Standing seam or membrane; sloped to drain water.

H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.

I. Cabinet Walls, Roof, and Base Insulation:

1. Type: Rigid polyurethane foam panels.
2. R-Value: R-13
3. Density: 2 lbs/cu ft.
4. Tested in accordance with ASTM D-1929-11.

J. Condensate Drain Pans:

1. Shape: Rectangular, double sloped.
2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.

   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

3. Configuration: Single wall.
4. Configuration: Double wall, with thermal breaks, and with space between walls filled with foam insulation and moisture-tight seal.
5. Material: 304 Stainless-steel sheet.
6. Drain Connection:

   a. Located on one end of pan, at lowest point of pan.
   b. Terminated with threaded nipple.
   c. Minimum Connection Size: NPS 1.

7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

2.4 SUPPLY FAN

A. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.

1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.
3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
4. Fan Enclosure: Easily removable enclosure around rotating parts.
5. Fan Balance: Precision balance fan below 0.08 inch/s at design speed with filter in.

B. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Enclosure: Open dripproof.
3. Motor Bearings: 200,000 hrs service with external lubrication points.
4. Efficiency: Premium efficient.
5. Service Factor: 1.15.

C. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with rubber isolators.

2.5 COOLING COILS

A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410.

B. Coil Casing Material: Stainless steel.

C. Tube Material: Copper.

D. Tube Header Material: Manufacturer's standard material.

E. Fin Material: Aluminum.

F. Fin and Tube Joints: Mechanical bond.

G. Leak Test: Coils shall be leak tested with air underwater.

H. Circuitry: Interlaced Circuitry.

I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.

2.6 REFRIGERATION SYSTEM

A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."

B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.

C. Compressors: Digital Scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.

D. Refrigerant: R-410A.

1. Classified as Safety Group A1 according to ASHRAE 34.
2. Provide unit with operating charge of refrigerant.

E. Refrigeration System Specialties:

1. Compressors shall be scroll type with thermal overload protection, independently circuited, and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

2. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam insulated panels to prevent the transmission of noise outside the cabinet.
3. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
4. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
5. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and factory installed liquid line filter driers.
6. Each refrigeration circuit shall be provided with an adjustable temperature sensor freeze stat which shuts down the cooling circuits when the evaporator coil tubing falls below the setpoint.
7. Each refrigeration circuit shall include adjustable compressor lockouts.
8. Each capacity stage shall be equipped with an adjustable, 20 second delay timer to prevent multiple capacity stages from starting all at once.
9. Each capacity stage shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.
10. Each refrigeration circuit shall be equipped with a liquid line sight glass.
11. Each refrigeration circuit shall be equipped with suction and discharge compressor isolation valves.

F. Capacity Control:

1. Unit shall include two variable capacity scroll compressors capable of modulation from 10-100% capacity and two standard on/off compressors.
2. Lead refrigeration circuit(s) shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. Second circuit shall be equipped with on/off reheat.

G. Refrigerant condenser and reheat condenser coils:

1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410.
2. Tube Material: Aluminum microchannel.
3. Fin Material: Aluminum.
4. Fin and Tube Joint: Mechanical bond.
5. Leak Test: Coils shall be leak tested with air underwater.

H. Condenser Fan Assembly:

1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.Condenser fans shall be VFD driven variable speed for condenser head pressure control. Factory provided and factory programmed VFDs shall

continuously modulate the fan air flow to maintain head pressure at acceptable levels. Cooling operation shall be allowed down to 35°F with adjustable compressor lockouts.

2. Fan Motors:

   a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Motor Enclosure: ODP with rain guard.
   c. Motor Bearings: Permanently lubricated bearings.
   d. Built-in overcurrent and thermal-overload protection.
   e. Efficiency: Premium efficient.
   f. NEMA Design: Manufacturer's standard.
   g. Service Factor: 1.15.

3. Fan Safety Guards: Steel with corrosion-resistant coating.

I. Safety Controls:

1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

2.7 INDIRECT-FIRED GAS FURNACE HEATING

A. Furnace Assembly:

1. Factory assembled, piped, and wired.
2. Comply with requirements in NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
3. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners:

1. Heat-Exchanger Material: Stainless steel with a minimum thermal efficiency of 80 percent.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark with flame sensor.

C. Heat-Exchanger Drain Pan Material: Stainless steel.

D. Venting: Gravity vented.

E. Venting: Power vent with integral, motorized centrifugal fan interlocked with gas valve.

F. Safety Controls:

1. Gas Control Valve: Electronic 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 STEAM HUMIDIFIER COIL

A. Steam humidifier coil shall be field-installed. Refer to specification section 238413 "Humidifiers".

2.9 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.10 FILTERS

A. Refer to schedule for filtering requirements.

B. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Meet ASHRAE 52.1 requirements.
3. See equipment schedule on plans.

C. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Extended surface filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

2.11 ELECTRICAL POWER CONNECTIONS

A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.

B. Enclosure: NEMA 250, Type 4, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,

C. Wiring: Numbered and color-coded to match wiring diagram.

D. Wiring Location: Install factory wiring outside an enclosure in a raceway.

E. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:

1. 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 60947-4-1.
2. NEMA KS 1, heavy-duty, nonfusible switch.
3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

F. Factory-Mounted, Overcurrent-Protection Service: For each motor.

G. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

H. Controls: Factory wire unit-mounted controls where indicated.

I. Lights: Factory wire unit-mounted lights.

J. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.

K. Control Relays: Auxiliary and adjustable time-delay relays.

2.12 CONTROLS

A. Provide control equipment and sequences of operation as specified and scheduled. Refer to specifications and plans.

2.13 ACCESSORIES

A. Refer to project schedule for accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

D. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."

E. Install separate devices furnished by manufacturer and not factory installed.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

G. Install drain pipes from unit drain pans to sanitary drain.

1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L, with soldered joints.

2. Pipe Size: Same size as condensate drain pan connection.

3.3 CONNECTIONS

A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Gas Piping Connections:

1. Comply with requirements in Section 231123 "Facility Natural-Gas Piping."
2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
3. Install AGA-approved flexible connectors.

C. Steam Piping Connections:

1. Comply with requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 Steam and Condensate Piping Specialties."
2. Install shutoff valve and union or flange on each supply connection.

3. Install, starting from the coil connection, union or flange, strainer, union, float and thermostatic trap, union, and shutoff valve.

D. Duct Connections:

1. Comply with requirements in Section 233113 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

E. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

   a. Measure gas pressure at manifold.
   b. Measure combustion-air temperature at inlet to combustion chamber.
   c. Measure flue-gas temperature at furnace discharge.
   d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
   e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

   a. High-limit heat exchanger.
   b. Alarms.

5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:

   a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
   b. Cooling coil entering-air, dry- and wet-bulb temperatures.
   c. Condenser coil entering-air dry-bulb temperature.
   d. Condenser coil leaving-air dry-bulb temperature.

7. Simulate maximum cooling demand and inspect the following:

a. Compressor refrigerant suction and hot-gas pressures.
b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

8. Inspect casing insulation for integrity, moisture content, and adhesion.
9. Verify that clearances have been provided for servicing.
10. Verify that controls are connected and operable.
11. Verify that filters are installed.
12. Clean coils and inspect for construction debris.
13. Clean furnace flue and inspect for construction debris.
14. Inspect operation of power vents.
15. Purge gas line.
16. Inspect and adjust vibration isolators and seismic restraints.
17. Verify bearing lubrication.
18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.
24. Adjust and inspect high-temperature limits.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

COT-237433

END OF SECTION 237433

SECTION 238123.13 - COMPUTER-ROOM AIR-CONDITIONERS, CEILING-MOUNTED UNITS

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 ceiling-mounted, computer-room air conditioners.

1.3 DEFINITIONS

A. COP: Coefficient of performance.

B. EER: Energy efficiency ratio.

C. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For computer-room air conditioners.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners 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.
2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.
3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three 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. Data Aire Inc.
2. Liebert; a brand of Emerson Electric Co.
3. Stulz-ATS.

2.2 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 Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

2.3 MANUFACTURED UNITS

A. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls.

1. Mounting Configuration: Exposed in the space.

B. Cabinet: Galvanized steel serviceable from one side, with baked-enamel finish, insulated with 1/2-inch- thick duct liner, and mounting bracket attached to the unit.

1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches, with filter.
2. Unit with 24-by-48-inch air distribution plenum, with integral MERV 8 filter and three-way air distribution.
3. Unit with two-speed, centrifugal direct-drive fan.
4.
5. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Supply-Air Fan:
1. Plug/plenum, single inlet, direct drive, electronically commutated, and variable speed.

D. Refrigeration System:

1. Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit Components:

   a. Low-pressure switch.
   b. Manually reset, high-pressure switch.
   c. Thermal-expansion valve with external equalizer.
   d. Sight glass with moisture indicator.
   e. Service shutoff valves.
   f. Charging valves.
   g. Hot-gas bypass.
   h. Refrigerant charge.

3. Refrigerant: R-407C or R-410A.

4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
5. Refrigerant line sets precharged in lengths as required by site conditions
6. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.

    a. Mount stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir under coil assembly.

7. Remote, Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with direct-drive fan.
8. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

E. Electric-Resistance Reheat Coil:

1. Finned-tube electric elements with contactor.
2. Dehumidification relay.
3. High-temperature-limit switches.
4. SCR to proportionally control the reheat elements providing precise temperature control.

F. Filter: 1-inch- thick, disposable, glass-fiber media.
1. Arrestance: 90 percent, according to ASHRAE 52.2.
2. MERV: 8 according to ASHRAE 52.2.

G. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
2. Control: Fully modulating to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
3. Drain Cycle: Field-adjustable drain duration and drain interval.

H. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

I. Single point power kit permitting single electrical feed to the evaporator and condensing unit of a close-coupled system.

J. Epoxy-coated, step-down transformer suitable for mounting on the outdoor condensing unit to provide it with 277-V input power.

K. Control System:

1. Microprocessor unit-mounted panel.
2. Fan contactor.
3. Compressor contactor.
4. Compressor start capacitor.
5. Control transformer with circuit breaker.
6. Solid-state temperature- and humidity-control modules.
7. Humidity contactor.
8. Time-delay relay.
9. Heating contactor.
10. Smoke sensor.
11. Filter clog switch.
12. Alarm contacts.
13. High-temperature thermostat.
14. Solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.
15. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.
16. BACnet interface capability for connection to BAS.

L. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   c. .

2.4 CAPACITIES AND CHARACTERISTICS

A. Refer to schedule for capacities and characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Install computer-room air conditioners coordinated with computer-room access flooring Installer.

C. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B.

D. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and elastomeric hangers of size required to support weight of computer-room air conditioner.

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

E. Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric pads on concrete base. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for condensate drain and humidifier flushing system.

D. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 238123.13

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Routing of refrigerant piping with respect to sensitive equipment.
3. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: Five year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (unless otherwise noted in specific products section):

1. AAON.
2. Carrier Corporation; a unit of United Technologies Corp.
3. Lennox Industries, Inc.; Lennox International.
4. Trane.
5. YORK; a Johnson Controls company.

2.2 INDOOR UNITS

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. All cabinet walls, access doors, and roof shall be fabricated of double wall G90 galvanized steel on both sides with a thermal break and insulated with impact resistant, rigid polyurethane foam panels. Insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610 deg F.
3. Hinged access panels.
4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
   a. Coil shall have a flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively. Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B 117-90 test procedures. Coated coil shall receive a spray-applied, UN-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 5 year warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The written instructions for installation, operation, coil cleaning, maintenance, and record keeping must be followed to avoid voiding coating warranty.
5. Interior of cabinet and exterior of cabinet shall be coated with corrosion resistant coating. Corrosion protection shall be capable of withstanding at least 2,500 hours with no visible corrosive effects when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedures.
6. Fan: Backward-curved wheel of galvanized steel; directly connected to motor.
7. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
   d. Blower and motor assembly shall be dynamically balanced.
   e. Blow and motor assembly shall be isolated with neoprene gasket.
   f. Motor shall be a high efficiency electronically commutated motor (ECM) and speed adjustment shall be made via a dial.
8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

9. Filters: Construction filters shall be used during construction; units shall not include filters during normal operation.
10. Condensate Drain Pans:

    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face.
2) Depth: A minimum of 2 inches deep.

b. Type 304 stainless-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

11. Controls shall be provided for entire system including condensing unit. Controls shall receive a signal from a thermostat and shall operate according to factory-programmed controls to maintain room temperature. Controls shall include a dry contact to output unit status to the building automation system.

2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in manufacturer's standard colort, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

   a. Compressor Type: Scroll.
   b. As indicated on schedule, two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch. Each capacity stage shall be equipped with a 5 minute off delay timer to prevent compressor short cycling. Each capacity stage shall be equipped with an adjustable 20 second delay timer to prevent multiple capacity stages from starting simultaneously.
   c. Refrigerant Charge: R-410A.
   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
   e. All refrigeration circuits shall be provided with external hot gas bypass to protect against evaporator frosting and to prevent excessive compressor cycling.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Electronically commutated motor. Shall be provided with on/off condenser fan cycling head pressure control and adjustable compressor lockout.
6. Low Ambient Kit: Permits operation down to 0 deg F.

7. Mounting Base: Polyethylene.
8. Provide factory-installed, painted galvanized steel condenser coil guards on the face of the condenser coil.
9. Controls shall be included in factory-provided and installed controls in air handler.

2.4 ACCESSORIES

A. Thermostat: Low voltage with LCD readout and subbase to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

1. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L ACR, annealed-temper tubing and wrought-copper fittings with brazed or silver soldered joints.
2. Refrigerant lines shall be individually insulated in twin-tube, flexible, closed-cell, CFC-free elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per SQq Ft/°F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 per ASTM E 84.

D. Drain Hose: For condensate.

2.5 CAPACITIES AND CHARACTERISTICS

A. Cooling and Heating Capacity:

1. See drawings for all capacity information for all units

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports as indicated on drawings.

D. Equipment Mounting:
   1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238216.14 - COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes electric resistance air coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Shop Drawings: Include 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: For air coils to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Reznor
   2. Indeeco
   3. Qmark
   4. Markel
   5. Neptronic

B. Testing Agency Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Coil Assembly: Comply with UL 1995.

D. Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.

E. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, and fastened to supporting brackets.

F. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.

   1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

G. Frames: Galvanized-steel channel frame, minimum 0.052 inch thick for flanged mounting.

H. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:

   1. Magnetic contactor.
   2. Mercury contactor.
   3. Toggle switches; one per step.
   4. Step controller.
   5. Time-delay relay.
   6. Pilot lights; one per step.
   7. Airflow proving switch.

I. Thermostats: Wall-mounted thermostats, with temperature range from 50 to 90 deg F, and 2.5 deg F throttling range.

J. Capacities and Characteristics:

1. Refer to schedules for capacities and characteristics

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

END OF SECTION 238216.14

SECTION 238413 - HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following humidifiers:
   1. Self-contained.

1.3 DEFINITION

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.

   1. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

   1. Structural members to which humidifiers will be attached.
   2. Size and location of initial access modules for acoustical tile.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.7 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 ARI 640, "Commercial and Industrial Humidifiers."

1.8 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

B. Submit coordination drawings. Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components and dispersion tubes. Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, and required clearances.

PART 2 - PRODUCTS

2.1 SELF-CONTAINED HUMIDIFIERS

A. Gas-Fired Steam Generator: Factory assembled and tested.

1. Standard: Fabricate and label steam generator to comply with CSA.
2. Maximum Steam Pressure: 10 inches wg.
3. Burner Type: Natural-gas fired with modulating, low NOx infrared burner, 83.7% efficient as a minimum.
4. Refer to project details for connection requirements.
5. Ignition: Hot-surface ignition with flame safety system.
6. Combustion Chamber: Sealed with outdoor-air and flue-vent connections.
7. Heat-Exchanger Tank: Cleanable, ASTM A 666, Type 316L stainless steel with corrosion-resistant coating.
8. Shall be capable of operating with de-ionized water, reverse osmosis water, potable, and softened water without required modifications.
9. Shall produce clean, sterile, and efficient atmospheric pressure steam.
10. Humidifer shall include air gap for supply water to prevent “back-siphoning”.

B. Tank surfaces shall be insulated with minimum 1" thick insulation and enclosed within unit cabinetry.

C. Integral drain water cooler to ensure drain water tempering to 140 deg F.

D. Blow-down drain trap, factory-installed, enclosed in cabinet. Drain line shall include vacuum breaker to prevent siphon drainage of the tank.
   1. Blow down shall be set to maintain required water quality as required by manufacturer. Use manufacturer's required water quality ranges for water conductivity, hardness, silica concentration, alkaline, and chlorine concentration.

E. Freeze protection: tank shall automatically drain in the event of a power loss.

F. Level control: Automatic water level control within a separate float chamber, isolated from the boiling action. Dual magnetic float system. Cool fill water shall be supplied to the sensing chamber to keep the device cool.

G. Manifold: ASTM A 666, Type 304 stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends.
   1. Absorption distance shall be as per schedule.
   2. Single horizontal stainless steel header to provide steam to vertical distributor tubes and to reduce condensation losses. Dual header systems shall not be allowed.
   3. Square headers are not acceptable.
   4. Steam inlet and condensate return located on the same side and at the bottom of the header.
   5. Horizontal distribution tubes are not acceptable.
   6. Stainless steel nozzle inserts.
   7.

H. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.

I. Control Panel:

   1. Factory-wired disconnect switch.
   2. Liquid-crystal display.
   3. Programmable keyboard.
   4. Set-point adjustment.
   5. Warning signal indicating end of replaceable cylinder life.
   6. Low-voltage, control circuit.
   7. Diagnostic, maintenance, alarm, and status features.
   8. High-water sensor or to prevent overfilling.d

J. Controls:

1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.

2. Full function user interface with touch type keybad and backlit alphanumeric and graphic display.

3. Real time clock indicating date and time with battery backup.

4. Built-in controller with adjustable setpoint, proportional range, and integral feedback for use with humidity transducers.

5. Acceptance of industry standard analog continuous control demand signal.

6. Keypad programming to configure, monitor and control humidifier parameters:
   a. Relative humidity setpoint and actual conditions in space from humidity transducer.
   b. Relative humidity setpoint and actual conditions in duct.
   c. Relative humidity high limit setpoint and actual from humidity transducer.
   d. System demand in lb/hr of steam.
   e. On-screen service history with date stamp.
   f. On-screen fault history with troubleshooting list and date stamped.
   g. On-screen attention indication.
   h. Security loop with display status "open/close".
   i. Control Channel 1 demand %.
   j. Control Channel 2 demand %.
   k. Control mode.
   l. Control type.
   m. Manual capacity output adjustment range of 50-100% of rated capacity.
   n. Humidifier model, capacity, software version.
   o. Humidifier run time weighted hours.
   p. Date and Time.
   q. Keep warm function allowing the water temperature in the cylinder to be maintained at a high temperature for quick response of the unit to a call for humidity.
   r. Rapid modulation capability.
   s. Short cycling detection and correction diagnostics.
   t. Foam detection and correction capability.
   u. Scroll through start-up and troubleshooting checklist on graphic display.
   v. Self-diagnostics during start-up to system test to prevent unsafe operation of the unit.

7.

8. BACnet protocol interface.
9. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
10. Field-adjustable timer to control drain cycle for flush duration and interval.
11. Controls shall drain tanks if no demand for humidification for more than 72 hours.

K. Accessories:

1. Refer to schedule for accessories.

L. Capacities and Characteristics:

1. Refer to schedule for capacities and characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.

B. Seal humidifier manifold duct or plenum penetrations with flange.

C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install manifold supply piping pitched to drain condensate back to humidifier.

E. Install drip leg upstream from steam trap a minimum of 12 inches tall for proper operation of trap.

F. Equipment Mounting:
1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

G. Install gas-fired steam generators according to NFPA 54.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.
2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

C. Install piping from safety relief valves to nearest floor drain.

D. Connect gas piping full size to steam-generator, gas-train inlet with union. Gas piping materials and specialties are specified in Section 231123 "Facility Natural-Gas Piping."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. 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.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Section 017900 "Demonstration and Training."

COT-238413

END OF SECTION 238413

SECTION 283112 - FIRE-ALARM SYSTEM

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. Manual fire-alarm boxes.
2. System smoke detectors.
3. Air-sampling smoke detectors.
4. Notification appliances.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. NICET: National Institute for Certification in Engineering Technologies.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Include the following and deliver copies to authorities having jurisdiction:
1. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Provide the "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
3. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.

4. Record copy of site-specific software.

5. Provide the "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
   a. Equipment tested.
   b. Frequency of testing of installed components.
   c. Frequency of inspection of installed components.
   d. Requirements and recommendations related to results of maintenance.
   e. Manufacturer's user training manuals.
6. Manufacturer's required maintenance related to system warranty requirements.
7. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.7 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

   1. Notify Architect no fewer than seven days in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Architect's written permission.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.8 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment 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 new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with and operate as an extension of existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded system dedicated to fire-alarm service only.

C. All components provided shall be listed for use with the selected system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Smoke detectors.
3. Duct smoke detectors.
4. Automatic sprinkler system water flow.
5. Fire-extinguishing system operation.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.

2. Identify alarm zone at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Activate elevator power shunt trip.
10. Activate emergency lighting control.
11. Activate emergency shutoffs for gas and fuel supplies.
12. Record events in the system memory.
13. Record events by the system printer.
14. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and systems:

1. Valve supervisory switch.
2. Alert and Action signals of air-sampling detector system.
3. Elevator shunt-trip supervision.
4. Independent fire-detection and -suppression systems.
5. User disabling of zones or individual devices.
6. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in internal circuits of fire-alarm control unit.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Hose cabinet door open.

E. System Trouble and Supervisory Signal Actions:

1. Initiate notification appliances.
2. Annunciate at fire-alarm control unit and remote annunciators.
3. Record the event on system printer.
4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.
6. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Operating at 24-V dc, nominal.
2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
3. Integral Visual-Indicating Light: LED type, indicating detector has operated.
4. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors: Comply with UL 268.

C. Ionization Smoke Detector: Comply with UL 268.

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Remote indication and test station. Operating key switch initiates an alarm test.
2. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
3. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
4. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

E. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.
2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.

a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.

3. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
4. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

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 and monitoring equipment as necessary to extend the existing control and monitoring functions to the new points. New components shall be capable of merging with the existing configuration without degrading the performance of either system.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

E. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place, except during system testing. Remove cover prior to system turnover.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

H. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

I. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. Connect supervised interface devices to the following devices and systems. Install the interface device less than 36 inches from the device controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Architect and authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Visual Inspection: Conduct the visual inspection prior to testing.

   a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing, and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with the visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests listed in the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283112

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