

PROJECT:

# Kensington Fire Station #25 Renovation and Addition

Aspen Hill, MARYLAND



OWNER:

MONTGOMERY COUNTY

## BID SET SPECIFICATIONS

## VOLUME II

August 28, 2017  
IFB # 1073301



HG Architects  
*Architect*

Adtek  
*Civil & Structural Engineer*

Adtek  
*Structural Engineer*

S3E Klingemann  
*MEP Engineer*

TRC Consultants  
*Cost Estimator*



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**SECTION 21 0500****COMMON WORK RESULTS FOR FIRE SUPPRESSION****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Mechanical sleeve seals.
  - 3. Sleeves.
  - 4. Escutcheons.
  - 5. Grout.
  - 6. Concrete bases.
  - 7. Supports and anchorages.

**1.2 DEFINITIONS**

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

**1.3 SUBMITTALS**

- A. Welding certificates.

**1.4 QUALITY ASSURANCE**

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## **PART 2 - PRODUCTS**

### **2.1 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.2 JOINING MATERIALS**

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

### **2.3 MECHANICAL SLEEVE SEALS**

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

**2.4 SLEEVES**

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

**2.5 ESCUTCHEONS**

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated and rough brass.

**2.6 GROUT**

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION****3.1 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.



1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### **3.2 PIPING JOINT CONSTRUCTION**

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
  2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

### **3.3 CONCRETE BASES**

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

### **3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES**

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### **3.5 ERECTION OF WOOD SUPPORTS AND ANCHORAGES**

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### **3.6 GROUTING**

- A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.

- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

**END OF SECTION 21 0500**



**SECTION 210800****COMMISSIONING OF FIRE PROTECTION****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The purpose of this Section is to specify Division 21 responsibilities in the commissioning process which are being directed by the Commissioning Authority (CxA). Other Fire Protection systems testing may be required under the direction of the Construction Manager (CM) or General Contractor (GC).
- B. Commissioning requires the participation of Division 21 Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents.
- C. The contractor shall execute all commissioning responsibilities assigned to them described in Section 01 75 00 "General Commissioning Requirements", the Contract Documents, and in the Commissioning Plan issued by the CxA.

**1.2 DEFINITIONS**

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

**1.3 INFORMATIONAL SUBMITTALS**

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

**1.4 RESPONSIBILITIES**

- A. Fire Protection Contractor: The commissioning responsibilities applicable to the Division 21 contractor are as follows (all references apply to commissioned equipment):
  - 1. Construction and Acceptance Phases
    - a. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the commissioning process.
    - b. Contractors shall provide product data and shop drawing submittals to the CxA for commissioned equipment during normal submittal procedures.
    - c. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of startup and functional testing procedures
      - 1) Typically this will include detailed manufacturer installation and startup, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, and full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA
      - 2) The CxA may request further documentation necessary for the commissioning process
      - 3) This data request may be made prior to normal submittals

- d. Provide a copy of the O&M manual submittals of commissioned equipment, through normal channels, for the CxA for review
  - e. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, drawings or equipment documentation is not sufficient for writing detailed testing procedures.
  - f. Provide assistance to the CxA in preparation of the specific functional performance shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
  - g. Develop a full startup and initial checkout plan using manufacturer's startup procedures and the pre-functional checklists from the CxA. Submit manufacturer's detailed startup procedures and the full startup plan and procedures and other requested equipment documentation to CxA for review.
  - h. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
  - i. Address current A/E punch list items before functional testing.
  - j. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
  - k. 017500, and Section 3.9. Assist the CxA in interpreting the monitoring data, as necessary.
  - l. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC, CM and A/E and retest the equipment.
  - m. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
  - n. During construction, maintain as-built red-line drawings for all drawings and final CAD as-built for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.
  - o. Provide training of the Owner's operating personnel as specified.
  - p. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  - q. Participate in orientation and inspection for Division 21 systems, assemblies, equipment, and component maintenance as directed by the CxA.
  - r. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
  - s. Inform the CxA 2 (two) weeks in advance of any third party or AHJ testing.
2. Warranty Period
- a. Execute deferred functional performance testing, witnessed by the CxA, according to the specifications
  - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing

## 1.5 COMMISSIONING DOCUMENTATION

- A. Contractor to provide the following information to the CxA for inclusion in the commissioning plan:
- 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
  - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Division 21 systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that Division 21 systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.

## **1.6 RELATED WORK**

- A. Refer to Section 017500 for a listing of all sections where commissioning requirements are found.

## **PART 2 - PRODUCTS**

### **2.1 TEST EQUIPMENT**

- A. Division 21 shall provide all test equipment necessary to fulfill the testing requirements of this Division.
- B. Refer to Section 017500 for additional Division 21 requirements.

## **PART 3 - EXECUTION**

### **3.1 SUBMITTALS**

- A. Division 21 shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 017500 for additional Division 21 requirements

### **3.2 STARTUP AND PRE-FUNCTIONAL PROCEDURES**

- A. The Fire Protection contractors shall follow the startup and initial checkout procedures listed in the Responsibilities list in this section and in 017500. Division 21 has startup responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the commissioning agent or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and CM. Beginning system testing before full completion does not relieve the Contractor of responsibility for fully completing the system, including all pre-functional checklists as soon as possible.
- C. Certify that Fire Protection systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- D. Certify that Fire Protection instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

- E. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- F. Inspect and verify the position of each device and interlock identified on checklists.
- G. Testing Instrumentation: Provide and install measuring instruments and logging devices to record test data as directed by the CxA.
- H. The CxA along with the Division 21 Contractor shall prepare detailed testing plans, procedures, and checklists for Fire Protection systems, subsystems, and equipment.
- I. Pipe system cleaning, flushing, and hydrostatic test requirements are specified in Fire Protection piping Sections. Fire Protection Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, and testing plan and final reports to the CxA. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, and hydrostatic testing plan.
  - 2. Description of equipment for flushing operations.
  - 3. Minimum flushing water velocity.
  - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, and hydrostatically tested.

### **3.3 FUNCTIONAL PERFORMANCE TESTS**

- A. Refer to Section 3.9 for a list of systems to be commissioned.
- B. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- C. Scope of Fire Protection testing shall include entire Fire Protection installation.
- D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. If tests cannot be completed because of a deficiency outside the scope of the Fire Protection system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.



**3.4 TESTING DOCUMENTATION, NON-CONFORMANCE, AND APPROVALS**

- A. Refer to Section 017500 for specific details on non-conformance issues relating to pre-functional checklists and tests.
- B. Refer to Section 017500 for issues relating to functional performance tests.

**3.5 OPERATION AND MAINTENANCE MANUALS (O&M) MANUALS**

- A. Division 21 shall compile and prepare documentation for all equipment and systems covered in Division 21 and deliver to the CM or GC for inclusion in the O&M manuals, according to Sections 013300 and 017700.
- B. The CxA shall receive a copy of the O&M manuals for concurrent review.

**3.6 TRAINING OF OWNER PERSONNEL**

- A. The CM or GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 017500 for additional details.
- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 017500 for additional details.
- C. Provide the CxA with a training plan eight (8) weeks before the planned training according to the outline described in Section 017500.
- D. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned Fire Protection equipment or system.
- E. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
- F. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- G. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
- H. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
- I. Training shall include:
  - 1. Use the printed installation, operation and maintenance instruction material included in the O&M manuals
  - 2. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory

- suggestions. The training shall include startup, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
3. Discuss relevant health and safety issues and concerns.
  4. Discuss warranties and guarantees.
  5. Cover common troubleshooting problems and solutions.
  6. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
  7. Discuss any peculiarities of equipment installation or operation.
  8. The format and training agenda in Guidelines for Commissioning HVAC Systems, ASHRAE, Guideline 0-2005 is recommended.
  9. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as appropriate
- J. Hands-on training shall include startup and operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- K. Training shall occur after functional testing is complete, unless approved otherwise by the CM, Owner, and CxA.

### **3.7 DEFERRED TESTING**

- A. Refer to Section 017500 for requirements of deferred testing.

### **3.8 WRITTEN WORK PRODUCTS**

- A. Written work products of Contractors will consist of the startup and initial checkout plan described in Section 017500 and the filled out startup, initial checkout and pre-functional checklists.

### **3.9 EQUIPMENT AND ASSOCIATED SYSTEMS TO BE COMMISSIONED**

<b>SECTION</b>	<b>SYSTEM DESCRIPTION</b>	<b>SAMPLING</b>
211313	WET-PIPE SPRINKLER SYSTEMS	100%
211316	DRY-PIPE SPRINKLER SYSTEMS	100%

**END OF SECTION 211313**

**SECTION 21 1313****WET-PIPE SPRINKLER SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Excess-pressure pumps.
6. Alarm devices.
7. Pressure gages.

**B. Related Sections:**

1. Division 21 Section "Common Work Results for Fire Suppression+.
2. Division 21 Section "Dry-Pipe Sprinkler Systems" for Dry-Pipe Sprinkler Piping.
3. Division 21 Section "Facility Fire-Suppression Water-Service Piping+.

**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 (1200-kPa) 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.
1. Available fire-hydrant flow test records indicate the following conditions:
    - a. Date: March 20, 2004.
    - b. Time: Not Available
    - c. Performed by: Fairfax Water Authority
    - d. Location of Residual Fire Hydrant R: Across from existing church, intersection of Hayden Lane and Know Road.
    - e. Static Pressure at Residual Fire Hydrant R: 77 psig
    - f. Measured Flow at Flow Fire Hydrant F: 1000 gpm
    - g. Residual Pressure at Residual Fire Hydrant R: 71 psig

- C. Sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: 20 percent, including losses through water-service piping, valves, and backflow preventers.
  2. Sprinkler Occupancy Hazard Classifications:
    - a. Building Service Areas: Ordinary Hazard, Group 1.
    - b. Churches: Light Hazard.
    - c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
    - d. General Storage Areas: Ordinary Hazard, Group 1.
    - e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
    - f. Office and Public Areas: Light Hazard.
  3. Minimum Density for Automatic-Sprinkler Piping Design:
    - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
    - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
    - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m) area.
  4. Maximum Protection Area per Sprinkler: Per UL listing.
  5. Maximum Protection Area per Sprinkler:
    - a. Office Spaces: 120 sq. ft. (11.1 sq. m) 225 sq. ft. (20.9 sq. m).
    - b. Storage Areas: 130 sq. ft. (12.1 sq. m).
    - c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
    - d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
    - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
  6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
    - a. Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
    - b. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 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.
  1. Wiring Diagrams: For power, signal, and control wiring.
- 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 professional engineer 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. Welding certificates.

- G. 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."
- H. Field quality-control reports.
- I. 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 engineering responsibility. Base calculations on results of fire-hydrant flow test.
    - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding 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.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems."
  - 2. Including Four Stories in Height."
  - 3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

## **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, 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. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
- D. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME 16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- I. 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: 250 psig (1725 kPa) 300 psig (2070 kPa) 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.
- J. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig (1200-kPa) pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
  - 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. Victaulic Company.
    - b. Grinnell Supply Sales Company.

## 2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) 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 LISTED FIRE-PROTECTION VALVES****A. General Requirements:**

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating: 175 psig (1200 kPa).

**B. Check Valves:**

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. AFAC Inc.
  - b. American Cast Iron Pipe Company; Waterous Company Subsidiary.
  - c. Anvil International, Inc.
  - d. Clow Valve Company; a division of McWane, Inc.
  - e. Crane Co.; Crane Valve Group; Crane Valves.
  - f. Crane Co.; Crane Valve Group; Jenkins Valves.
  - g. Crane Co.; Crane Valve Group; Stockham Division.
  - h. Fire-End & Croker Corporation.
  - i. Fire Protection Products, Inc.
  - j. Fivalco Inc.
  - k. Globe Fire Sprinkler Corporation.
  - l. Groeniger & Company.
  - m. Kennedy Valve; a division of McWane, Inc.
  - n. Matco-Norca.
  - o. Metraflex, Inc.
  - p. Milwaukee Valve Company.
  - q. Mueller Co.; Water Products Division.
  - r. NIBCO INC.
  - s. Potter Roemer.
  - t. Reliable Automatic Sprinkler Co., Inc.
  - u. Shurjoint Piping Products.
  - v. Tyco Fire & Building Products LP.
  - w. United Brass Works, Inc.
  - x. Venus Fire Protection Ltd.
  - y. Victaulic Company.
  - z. Viking Corporation.
  - aa. Watts Water Technologies, Inc.
2. Standard: UL 312.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Type: Swing check.
5. Body Material: Cast iron.
6. End Connections: Flanged or grooved.

**C. Bronze OS&Y Gate Valves:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.

- c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. United Brass Works, Inc.
- 2. Standard: UL 262.
  - 3. Pressure Rating: 175 psig (1200 kPa).
  - 4. Body Material: Bronze.
  - 5. End Connections: Threaded.

D. Iron OS&Y Gate Valves:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
  - b. American Valve, Inc.
  - c. Clow Valve Company; a division of McWane, Inc.
  - d. Crane Co.; Crane Valve Group; Crane Valves.
  - e. Crane Co.; Crane Valve Group; Jenkins Valves.
  - f. Crane Co.; Crane Valve Group; Stockham Division.
  - g. Hammond Valve.
  - h. Milwaukee Valve Company.
  - i. Mueller Co.; Water Products Division.
  - j. NIBCO INC.
  - k. Shurjoint Piping Products.
  - l. Tyco Fire & Building Products LP.
  - m. United Brass Works, Inc.
  - n. Watts Water Technologies, Inc.
- 2. Standard: UL 262.
- 3. Pressure Rating: 250 psig (1725 kPa) minimum.
- 4. Body Material: Cast or ductile iron.
- 5. End Connections: Flanged or grooved.

E. Indicating-Type Butterfly Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Anvil International, Inc.
  - b. Fivalco Inc.
  - c. Global Safety Products, Inc.
  - d. Kennedy Valve; a division of McWane, Inc.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Shurjoint Piping Products.
  - h. Tyco Fire & Building Products LP.
  - i. Victaulic Company.
- 2. Standard: UL 1091.
- 3. Pressure Rating: 175 psig (1200 kPa) minimum.
- 4. Valves NPS 2 (DN 50) and Smaller:
  - a. Valve Type: Ball or butterfly.



- b. Body Material: Bronze.
  - c. End Connections: Threaded.
- 5. Valves NPS 2-1/2 (DN 65) and Larger:
  - a. Valve Type: Butterfly.
  - b. Body Material: Cast or ductile iron.
  - c. End Connections: Flanged, grooved, or wafer.
- 6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

## **2.5 TRIM AND DRAIN VALVES**

### **A. General Requirements:**

- 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
- 2. Minimum Pressure Rating: 175 psig (1200 kPa).

### **B. Ball Valves:**

- 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. Affiliated Distributors.
  - b. Anvil International, Inc.
  - c. Barnett.
  - d. Conbraco Industries, Inc.; Apollo Valves.
  - e. Fire-End & Croker Corporation.
  - f. Fire Protection Products, Inc.
  - g. Flowserve.
  - h. FNW.
  - i. Jomar International, Ltd.
  - j. Kennedy Valve; a division of McWane, Inc.
  - k. Kitz Corporation.
  - l. Legend Valve.
  - m. Metso Automation USA Inc.
  - n. Milwaukee Valve Company.
  - o. NIBCO INC.
  - p. Potter Roemer.
  - q. Red-White Valve Corporation.
  - r. Southern Manufacturing Group.
  - s. Stewart, M. A. and Sons Ltd.
  - t. Tyco Fire & Building Products LP.
  - u. Victaulic Company.
  - v. Watts Water Technologies, Inc.

## **2.6 SPECIALTY VALVES**

### **A. General Requirements:**

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. AFAC Inc.
  - b. Globe Fire Sprinkler Corporation.
  - c. Reliable Automatic Sprinkler Co., Inc.
  - d. Tyco Fire & Building Products LP.
  - e. Venus Fire Protection Ltd.
  - f. Victaulic Company.
  - g. Viking Corporation.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. AFAC Inc.
  - b. Reliable Automatic Sprinkler Co., Inc.
  - c. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 (DN 20).
6. End Connections: Threaded.

## 2.7 FIRE-DEPARTMENT CONNECTIONS

A. Flush-Type, Fire-Department Connection:

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. AFAC Inc.
  - b. Elkhart Brass Mfg. Company, Inc.

- c. GMR International Equipment Corporation.
  - d. Guardian Fire Equipment, Inc.
  - e. Potter Roemer.
- 2. Standard: UL 405.
  - 3. Type: Flush, for wall mounting.
  - 4. Pressure Rating: 175 psig (1200 kPa) minimum.
  - 5. Body Material: Corrosion-resistant metal.
  - 6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
  - 7. Caps: Brass, lugged type, with gasket and chain.
  - 8. Escutcheon Plate: Rectangular, brass, wall type.
  - 9. Outlet: With pipe threads.
  - 10. Body Style: Horizontal.
  - 11. Number of Inlets: Two.
  - 12. Outlet Location: Back.
  - 13. Escutcheon Plate Marking: Similar to " AUTO SPKR."
  - 14. Finish: Bronze (No Exceptions).
  - 15. Outlet Size: NPS 4 (DN 100).

## 2.8 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 (1200 kPa) 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. Flow Detection and Test Assemblies:

- 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. AGF Manufacturing Inc.
  - b. Reliable Automatic Sprinkler Co., Inc.
  - c. Tyco Fire & Building Products LP.
  - d. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:

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. Elkhart Brass Mfg. Company, Inc.
  - b. Fire-End & Croker Corporation.
  - c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. AGF Manufacturing Inc.
  - b. Triple R Specialty.
  - c. Tyco Fire & Building Products LP.
  - d. Victaulic Company.
  - e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

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. CECA, LLC.
  - b. Corcoran Piping System Co.
  - c. Merit Manufacturing; a division of Anvil International, Inc.

2. Standard: UL 1474.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

1. Manufacturers: Subject to compliance with requirements, 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 (1200 kPa) minimum.
5. Size: Same as connected piping, for sprinkler.

## 2.9 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. AFAC Inc.
  2. Globe Fire Sprinkler Corporation.
  3. Reliable Automatic Sprinkler Co., Inc.
  4. Tyco Fire & Building Products LP.
  5. Venus Fire Protection Ltd.
  6. Victaulic Company.
  7. 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 (1200 kPa) minimum.
  3. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) 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-inch (12.7-mm) orifice 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. Special Coatings:
1. Wax.
  2. Lead.
  3. Corrosion-resistant paint.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Plastic, white finish, one piece, flat.
  2. Sidewall Mounting: Plastic, white finish, one piece, flat.
- G. Sprinkler Guards:
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. Reliable Automatic Sprinkler Co., Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
    - d. Viking Corporation.
  2. Standard: UL 199.
  3. Type: Wire cage with fastening device for attaching to sprinkler.
  4. Sprinkler types and finishes
    - a. Acoustic Tile Ceilings: Concealed, white covers, quick response.
    - b. Domes: Sidewall, white finish, quick response.
    - c. Dome Mid-Slope Ceilings: Concealed, white covers, quick response.
    - d. Wood Ceilings: Concealed, brown covers, quick response.

## 2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Flow Indicators:
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. ADT Security Services, Inc.
    - b. McDonnell & Miller; ITT Industries.
    - c. Potter Electric Signal Company.
    - d. System Sensor; a Honeywell company.
    - e. Viking Corporation.
    - f. Watts Industries (Canada) Inc.
  2. Standard: UL 346.

3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig (1725 kPa).
7. Design Installation: Horizontal or vertical.

C. Valve Supervisory Switches:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
  - b. Kennedy Valve; a division of McWane, Inc.
  - c. Potter Electric Signal Company.
  - d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

## 2.11 PRESSURE GAGES

- 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. AMETEK; U.S. Gauge Division.
  2. Ashcroft, Inc.
  3. Brecco Corporation.
  4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

## 2.12 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated finish with set-screws.
- C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.

- D. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw.
- E. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated finish with concealed hinge and set-screw.
- F. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed hinge, set-screw.
- G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- H. Split-Casting Floor Plates: Cast brass with concealed hinge.

### **2.13 SLEEVES**

- A. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- F. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
- G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set-screws.

### **2.14 SLEEVE SEALS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Advance Products & Systems, Inc.
  - 2. Calpico, Inc.
  - 3. Metraflex, Inc.
  - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Carbon steel.
  - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements.



**2.15 GROUT**

- A. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink, and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION****3.1 SERVICE-ENTRANCE PIPING**

- A. Connect sprinkler piping to water-service piping for service entrance to building. Retain one of two paragraphs below. Backflow preventers are recommended and are usually required by authorities having jurisdiction.
- B. Install shutoff valve, backflow preventer conforming to ASSE 1015, pressure gage, drain, and other accessories indicated at connection to water-service piping.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

**3.2 PIPING INSTALLATION**

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.

- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. 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.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. 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 (DN 8) 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.
- N. Fill sprinkler system piping with water.
- O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."

### 3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. 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.

### **3.4 VALVE AND SPECIALTIES INSTALLATION**

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
  - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
  - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

### **3.5 SPRINKLER INSTALLATION**

- A. Install sprinklers in suspended ceilings centered in both directions of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

**3.6 FIRE-DEPARTMENT CONNECTION INSTALLATION**

- A. Install wall-type, fire-department connections.
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

**3.7 ESCUTCHEON INSTALLATION**

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
  - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
  - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
  - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
  - 4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set-screw.
  - 5. Bare Piping in Equipment Rooms: One piece, stamped steel with set-screw stamped steel with spring clips.
  - 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

**3.8 SLEEVE INSTALLATION**

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE.
  2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
    - a. Extend sleeves 2 inches (50 mm) above finished floor level.
    - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."
  3. Sleeves for Piping Passing through Gypsum-Board Partitions:
    - a. PVC-pipe sleeves for pipes smaller than NPS 6 (DN 150).
    - b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
    - c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
  4. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE.
  5. Sleeves for Piping Passing through Exterior Concrete Walls:
    - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
    - b. Cast-iron wall-pipe sleeves for pipes NPS 6 (DN 150) and larger.
    - c. Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
  6. Sleeves for Piping Passing through Interior Concrete Walls:
    - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
    - b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
- L. 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 firestop materials and installations in Division 07 Section "Penetration Firestopping."

### **3.9 SLEEVE SEAL INSTALLATION**

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.10 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. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

**3.11 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. Start and run excess-pressure pumps.
  - 6. Coordinate with fire-alarm tests. Operate as required.
  - 7. Coordinate with fire-pump tests. Operate as required.
  - 8. 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.

**3.12 CLEANING**

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

**3.13 PIPING SCHEDULE**

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Wet-pipe sprinkler system, NPS 2 (DN 50) and 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, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
  - 3. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6 (DN 65 to DN 150), shall be the following:
  - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

**3.14 SPRINKLER SCHEDULE**

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
  2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
  3. Wall Mounting: Sidewall sprinklers.
  4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
  5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
  2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
  3. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

**END OF SECTION 21 1313**





**SECTION 22 0500****COMMON WORK RESULTS FOR PLUMBING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Sleeves.
  - 5. Escutcheons.
  - 6. Grout.
  - 7. Plumbing demolition.
  - 8. Equipment installation requirements common to equipment sections.
  - 9. Concrete bases.
  - 10. Supports and anchorages.

**1.2 DEFINITIONS**

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

**1.3 SUBMITTALS**

- A. Welding certificates.

**1.4 QUALITY ASSURANCE**

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## **PART 2 - PRODUCTS**

### **2.1 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.2 JOINING MATERIALS**

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
  - 1. ABS Piping: ASTM D 2235.
  - 2. CPVC Piping: ASTM F 493.
  - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - 4. PVC to ABS Piping Transition: ASTM D 3138.

### **2.3 DIELECTRIC FITTINGS**

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

## **2.4 MECHANICAL SLEEVE SEALS**

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Carbon steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## **2.5 SLEEVES**

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

**2.6 ESCUTCHEONS**

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated.

**2.7 GROUT**

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION****3.1 PLUMBING DEMOLITION**

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

**3.2 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble

mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### **3.3 PIPING JOINT CONSTRUCTION**

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  5. PVC Nonpressure Piping: Join according to ASTM D 2855.
  6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
  2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### **3.4 PIPING CONNECTIONS**

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
  2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### **3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS**

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

### **3.6 CONCRETE BASES**

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section ".

### **3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES**

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### **3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES**

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### **3.9 GROUTING**

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.



H. Cure placed grout.

**END OF SECTION 22 0500**



**SECTION 220519****METERS AND GAGES FOR PLUMBING PIPING****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Bimetallic-actuated thermometers.
  - 2. Liquid-in-glass thermometers.
  - 3. Thermowells.
  - 4. Dial-type pressure gages.
  - 5. Gage attachments.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Product certificates.
- C. Operation and maintenance data.

**PART 2 - PRODUCTS****2.1 BIMETALLIC-ACTUATED THERMOMETERS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Insert manufacturer's name; product name or designation or comparable product by one of the following:
  - 1. Ashcroft Inc.
  - 2. Ernst Flow Industries.
  - 3. Marsh Bellofram.
  - 4. Miljoco Corporation.
  - 5. Nanmac Corporation.
  - 6. Noshok.
  - 7. Palmer Wahl Instrumentation Group.
  - 8. REOTEMP Instrument Corporation.
  - 9. Tel-Tru Manufacturing Company.
  - 10. Terice, H. O. Co.
  - 11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - 12. Weiss Instruments, Inc.
  - 13. WIKA Instrument Corporation - USA.
  - 14. Winters Instruments - U.S.

- C. Standard: ASME B40.200.
- D. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch (76-mm) nominal diameter.
- E. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C).
- F. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- G. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
- H. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
- I. Window: Plain glass or plastic.
- J. Ring: Stainless steel.
- K. Element: Bimetal coil.
- L. Pointer: Dark-colored metal.
- M. Accuracy: Plus or minus 1 percent of scale range.

## **2.2 LIQUID-IN-GLASS THERMOMETERS**

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Flo Fab Inc.
    - b. Miljoco Corporation.
    - c. Palmer Wahl Instrumentation Group.
    - d. Tel-Tru Manufacturing Company.
    - e. Terice, H. O. Co.
    - f. Weiss Instruments, Inc.
    - g. Winters Instruments - U.S.
  - 2. Standard: ASME B40.200.
  - 3. Case: Cast aluminum; 7-inch (178-mm) nominal size unless otherwise indicated.
  - 4. Case Form: Adjustable angle unless otherwise indicated.
  - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
  - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
  - 7. Window: Glass or plastic.
  - 8. Stem: Aluminum Insert material and of length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  - 9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
  - 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Ernst Flow Industries.
  - b. Marsh Bellofram.
  - c. Miljoco Corporation.
  - d. Palmer Wahl Instrumentation Group.
  - e. REOTEMP Instrument Corporation.
  - f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - g. Weiss Instruments, Inc.
  - h. WIKA Instrument Corporation - USA.
2. Standard: ASME B40.200.
3. Case: Plastic; 7-inch (178-mm) nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
7. Window: Glass or plastic.
8. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.4 PRESSURE GAGES

### A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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. AMETEK, Inc.; U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Ernst Flow Industries.
  - d. Flo Fab Inc.
  - e. Marsh Bellofram.
  - f. Miljoco Corporation.
  - g. Noshok.
  - h. Palmer Wahl Instrumentation Group.
  - i. REOTEMP Instrument Corporation.
  - j. Tel-Tru Manufacturing Company.
  - k. Terice, H. O. Co.
  - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - m. Weiss Instruments, Inc.
  - n. WIKA Instrument Corporation - USA.
  - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) 6-inch (152-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8) NPS 1/4 or NPS 1/2 (DN 8 or DN 15) NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Brass.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

### B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:

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. AMETEK, Inc.; U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Flo Fab Inc.
  - d. Marsh Bellofram.
  - e. Miljoco Corporation.
  - f. Noshok.
  - g. Palmer Wahl Instrumentation Group.
  - h. REOTEMP Instrument Corporation.
  - i. Tel-Tru Manufacturing Company.
  - j. Terice, H. O. Co.
  - k. Weiss Instruments, Inc.

- I. WIKA Instrument Corporation - USA.
    - m. Winters Instruments - U.S.
  - 2. Standard: ASME B40.100.
  - 3. Case: Sealed type; plastic; 4-1/2-inch (114-mm) nominal diameter.
  - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  - 5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
  - 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
  - 8. Pointer: Dark-colored metal.
  - 9. Window: Glass or plastic.
  - 10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
- 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. AMETEK, Inc.; U.S. Gauge.
    - b. Ashcroft Inc.
    - c. Ernst Flow Industries.
    - d. Flo Fab Inc.
    - e. Marsh Bellofram.
    - f. Miljoco Corporation.
    - g. Noshok.
    - h. Palmer Wahl Instrumentation Group.
    - i. REOTEMP Instrument Corporation.
    - j. Tel-Tru Manufacturing Company.
    - k. Terice, H. O. Co.
    - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    - m. Weiss Instruments, Inc.
    - n. WIKA Instrument Corporation - USA.
    - o. Winters Instruments - U.S.
  - 2. Standard: ASME B40.100.
  - 3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter with back front flange and holes for panel mounting.
  - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  - 5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
  - 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
  - 8. Pointer: Dark-colored metal.
  - 9. Window: Glass or plastic.
  - 10. Ring: Metal.
  - 11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.
- D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
- 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. AMETEK, Inc.; U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Miljoco Corporation.
  - d. Noshok.
  - e. Palmer Wahl Instrumentation Group.
  - f. REOTEMP Instrument Corporation.
  - g. Tel-Tru Manufacturing Company.
  - h. Terice, H. O. Co.
  - i. Weiss Instruments, Inc.
  - j. WIKA Instrument Corporation - USA.
  - k. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Sealed type; plastic; 4-1/2-inch (114-mm) nominal diameter with front flange and holes for panel mounting.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of Grade B, plus or minus 2 percent of middle half of scale range.

## **2.5 GAGE ATTACHMENTS**

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.



- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install thermometers in the following locations:
  - 1. Inlet and outlet of each water heater.
  - 2. Inlets and outlets of each domestic water heat exchanger.
  - 3. Inlet and outlet of each domestic hot-water storage tank.
  - 4. Inlet and outlet of each remote domestic water chiller.
- K. Install pressure gages in the following locations:
  - 1. Building water service entrance into building.
  - 2. Inlet and outlet of each pressure-reducing valve.
  - 3. Suction and discharge of each domestic water pump.
- L. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- M. Adjust faces of meters and gages to proper angle for best visibility.

### **3.2 THERMOMETER SCHEDULE**

- A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
  - 1. Liquid-filled, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
  - 1. Liquid-filled, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
  - 1. Liquid-filled, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- D. Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:
  - 1. Liquid-filled, bimetallic-actuated type.
  - 2. Industrial-style, liquid-in-glass type.
- E. Thermometer stems shall be of length to match thermowell insertion length.

**3.3 THERMOMETER SCALE-RANGE SCHEDULE**

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).
- B. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C).
- C. Scale Range for Domestic Cold-Water Piping: 30 to 240 deg F (0 to plus 115 deg C).
- D. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).
- E. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C).
- F. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).
- G. Scale Range for Domestic Cooled-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C).

**3.4 PRESSURE-GAGE SCHEDULE**

- A. Pressure gages at discharge of each water service into building shall be one of the following:
  - 1. Liquid-filled, direct-mounted, metal case.
  - 2. Sealed, direct-mounted, plastic case.
- B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
  - 1. Liquid-filled, direct-mounted, metal case.
  - 2. Sealed, direct-mounted, plastic case.
- C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
  - 1. Liquid-filled, direct-mounted, metal case.
  - 2. Sealed, direct-mounted, plastic case.

**3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE**

- A. Scale Range for Water Service Piping: 0 to 100 psi (0 to 600 kPa).
- B. Scale Range for Water Service Piping: 0 to 160 psi (0 to 1100 kPa).
- C. Scale Range for Water Service Piping: 0 to 200 psi (0 to 1400 kPa).
- D. Scale Range for Domestic Water Piping: 0 to 100 psi (0 to 600 kPa).
- E. Scale Range for Domestic Water Piping: 0 to 160 psi (0 to 1100 kPa).
- F. Scale Range for Domestic Water Piping: 0 to 200 psi (0 to 1400 kPa).

**END OF SECTION 22 0519**

**SECTION 22 0523****GENERAL-DUTY VALVES FOR PLUMBING PIPING****PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Bronze gate valves.
8. Iron gate valves.
9. Bronze globe valves.
10. Iron globe valves.
11. Chainwheels.

**B. Related Sections:**

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

**1.2 SUBMITTALS**

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

**1.3 QUALITY ASSURANCE**

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

**PART 2 - PRODUCTS****2.1 GENERAL REQUIREMENTS FOR VALVES**

- A. Refer to valve schedule articles for applications of valves.

- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  - 1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
  - 2. Handwheel: For valves other than quarter-turn types.
  - 3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
  - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
  - 1. Gate Valves: With rising stem.
  - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Solder Joint: With sockets according to ASME B16.18.
  - 3. Threaded: With threads according to ASME B1.20.1.

## 2.2 BRASS BALL VALVES

- A. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:
  - 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. Kitz Corporation.
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. CWP Rating: 400 psig (2760 kPa).
    - c. Body Design: One piece.
    - d. Body Material: Forged brass.
    - e. Ends: Threaded.
    - f. Seats: PTFE or TFE.
    - g. Stem: Brass.
    - h. Ball: Chrome-plated brass.
    - i. Port: Reduced.
- B. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. DynaQuip Controls.
- d. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
- e. Hammond Valve.
- f. Jamesbury; a subsidiary of Metso Automation.
- g. Jomar International, LTD.
- h. Kitz Corporation.
- i. Legend Valve.
- j. Marwin Valve; a division of Richards Industries.
- k. Milwaukee Valve Company.
- l. NIBCO INC.
- m. Red-White Valve Corporation.
- n. RuB Inc.

2. 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: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

C. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:

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. Hammond Valve.
- b. Jamesbury; a subsidiary of Metso Automation.
- c. Legend Valve.
- d. Marwin Valve; a division of Richards Industries.
- e. Milwaukee Valve Company.

2. 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: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Regular.

**2.3 BRONZE BALL VALVES****A. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. American Valve, Inc.
  - b. Conbraco Industries, Inc.; Apollo Valves.
  - c. NIBCO INC.
2. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 400 psig (2760 kPa).
  - c. Body Design: One piece.
  - d. Body Material: Bronze.
  - e. Ends: Threaded.
  - f. Seats: PTFE or TFE.
  - g. Stem: Bronze.
  - h. Ball: Chrome-plated brass.
  - i. Port: Reduced.

**B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. American Valve, Inc.
  - b. Conbraco Industries, Inc.; Apollo Valves.
  - c. Crane Co.; Crane Valve Group; Crane Valves.
  - d. Hammond Valve.
  - e. Lance Valves; a division of Advanced Thermal Systems, Inc.
  - f. Legend Valve.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Red-White Valve Corporation.
  - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. 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 or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.

**C. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. American Valve, Inc.
  - b. Conbraco Industries, Inc.; Apollo Valves.
  - c. Crane Co.; Crane Valve Group; Jenkins Valves.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. DynaQuip Controls.
  - f. Hammond Valve.
  - g. Lance Valves; a division of Advanced Thermal Systems, Inc.
  - h. Milwaukee Valve Company.
  - i. NIBCO INC.
2. 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 or TFE.
  - h. Stem: Bronze.
  - i. Ball: Chrome-plated brass.
  - j. Port: Regular.

## **2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES**

- A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
  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. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
    - b. Conbraco Industries, Inc.; Apollo Valves.
    - c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
    - d. Crane Co.; Crane Valve Group; Jenkins Valves.
    - e. Crane Co.; Crane Valve Group; Stockham Division.
    - f. DeZurik Water Controls.
    - g. Flo Fab Inc.
    - h. Hammond Valve.
    - i. Kitz Corporation.
    - j. Legend Valve.
    - k. Milwaukee Valve Company.
    - l. NIBCO INC.
    - m. Norriseal; a Dover Corporation company.
    - n. Red-White Valve Corporation.
    - o. Spence Strainers International; a division of CIRCOR International, Inc.
    - p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

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. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. Conbraco Industries, Inc.; Apollo Valves.
- c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Crane Co.; Crane Valve Group; Stockham Division.
- f. DeZurik Water Controls.
- g. Flo Fab Inc.
- h. Hammond Valve.
- i. Kitz Corporation.
- j. Legend Valve.
- k. Milwaukee Valve Company.
- l. NIBCO INC.
- m. Norriseal; a Dover Corporation company.
- n. Red-White Valve Corporation.
- o. Spence Strainers International; a division of CIRCOR International, Inc.
- p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: NBR.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

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. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. American Valve, Inc.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
- e. Crane Co.; Crane Valve Group; Center Line.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.



- h. Flo Fab Inc.
- i. Hammond Valve.
- j. Kitz Corporation.
- k. Legend Valve.
- l. Milwaukee Valve Company.
- m. Mueller Steam Specialty; a division of SPX Corporation.
- n. NIBCO INC.
- o. Norriseal; a Dover Corporation company.
- p. Spence Strainers International; a division of CIRCOR International, Inc.
- q. Sure Flow Equipment Inc.
- r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Nickel-plated or -coated ductile iron.

D. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:

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. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. American Valve, Inc.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
- e. Crane Co.; Crane Valve Group; Center Line.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Flo Fab Inc.
- i. Hammond Valve.
- j. Kitz Corporation.
- k. Legend Valve.
- l. Milwaukee Valve Company.
- m. Mueller Steam Specialty; a division of SPX Corporation.
- n. NIBCO INC.
- o. Norriseal; a Dover Corporation company.
- p. Spence Strainers International; a division of CIRCOR International, Inc.
- q. Sure Flow Equipment Inc.
- r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: NBR.

- f. Stem: One- or two-piece stainless steel.
- g. Disc: Nickel-plated or -coated ductile iron.

## 2.5 BRONZE SWING CHECK VALVES

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

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. American Valve, Inc.
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Crane Co.; Crane Valve Group; Jenkins Valves.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. Hammond Valve.
  - f. Kitz Corporation.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Powell Valves.
  - j. Red-White Valve Corporation.
  - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - l. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 3.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B 62, bronze.
  - e. Ends: Threaded.
  - f. Disc: Bronze.

### B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Hammond Valve.
  - e. Kitz Corporation.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Red-White Valve Corporation.
  - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 4.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Horizontal flow.

- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: PTFE or TFE.

## 2.6 IRON SWING CHECK VALVES

### A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Hammond Valve.
  - e. Kitz Corporation.
  - f. Legend Valve.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Powell Valves.
  - j. Red-White Valve Corporation.
  - k. Sure Flow Equipment Inc.
  - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - m. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - e. Ends: Flanged.
  - f. Trim: Bronze.
  - g. Gasket: Asbestos free.

### B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.
2. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - e. Ends: Flanged.
  - f. Trim: Composition.
  - g. Seat Ring: Bronze.
  - h. Disc Holder: Bronze.

- i. Disc: PTFE or TFE.
- j. Gasket: Asbestos free.

## **2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL**

### **A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:**

- 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. NIBCO INC.
- 2. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - e. Ends: Flanged.
  - f. Trim: Bronze.
  - g. Gasket: Asbestos free.
  - h. Closure Control: Factory-installed, exterior lever and spring.

### **B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:**

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Hammond Valve.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - e. Ends: Flanged.
  - f. Trim: Bronze.
  - g. Gasket: Asbestos free.
  - h. Closure Control: Factory-installed, exterior lever and weight.

## **2.8 BRONZE GATE VALVES**

### **A. Class 125, NRS Bronze Gate Valves:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. American Valve, Inc.
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Crane Co.; Crane Valve Group; Jenkins Valves.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. Hammond Valve.
  - f. Kitz Corporation.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Powell Valves.
  - j. Red-White Valve Corporation.
  - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - l. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 1.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
  - d. Ends: Threaded or solder joint.
  - e. Stem: Bronze.
  - f. Disc: Solid wedge; bronze.
  - g. Packing: Asbestos free.
  - h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. American Valve, Inc.
  - b. Crane Co.; Crane Valve Group; Crane Valves.
  - c. Crane Co.; Crane Valve Group; Jenkins Valves.
  - d. Crane Co.; Crane Valve Group; Stockham Division.
  - e. Hammond Valve.
  - f. Kitz Corporation.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Powell Valves.
  - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - k. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
  - d. Ends: Threaded or solder joint.
  - e. Stem: Bronze.
  - f. Disc: Solid wedge; bronze.
  - g. Packing: Asbestos free.
  - h. Handwheel: Malleable iron, bronze, or aluminum.

**2.9 IRON GATE VALVES****A. Class 125, NRS, Iron Gate Valves:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Flo Fab Inc.
  - e. Hammond Valve.
  - f. Kitz Corporation.
  - g. Legend Valve.
  - h. Milwaukee Valve Company.
  - i. NIBCO INC.
  - j. Powell Valves.
  - k. Red-White Valve Corporation.
  - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - m. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-70, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - d. Ends: Flanged.
  - e. Trim: Bronze.
  - f. Disc: Solid wedge.
  - g. Packing and Gasket: Asbestos free.

**B. Class 125, OS&Y, Iron Gate Valves:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Flo Fab Inc.
  - e. Hammond Valve.
  - f. Kitz Corporation.
  - g. Legend Valve.
  - h. Milwaukee Valve Company.
  - i. NIBCO INC.
  - j. Powell Valves.
  - k. Red-White Valve Corporation.
  - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - m. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-70, Type I.

- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Material: ASTM A 126, gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Disc: Solid wedge.
- g. Packing and Gasket: Asbestos free.

## 2.10 BRONZE GLOBE VALVES

### A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.
  - c. Hammond Valve.
  - d. Kitz Corporation.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Powell Valves.
  - h. Red-White Valve Corporation.
  - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - j. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 1.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
  - d. Ends: Threaded[ **or solder joint**].
  - e. Stem and Disc: Bronze.
  - f. Packing: Asbestos free.
  - g. Handwheel: Malleable iron[, **bronze, or aluminum**].

### B. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.
  - c. NIBCO INC.
  - d. Red-White Valve Corporation.
2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
  - d. Ends: Threaded or solder joint.
  - e. Stem: Bronze.

- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

## **2.11 IRON GLOBE VALVES**

### **A. Class 125, Iron Globe Valves:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Hammond Valve.
  - e. Kitz Corporation.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Powell Valves.
  - i. Red-White Valve Corporation.
  - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - k. Zy-Tech Global Industries, Inc.
2. Description:
  - a. Standard: MSS SP-85, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - d. Ends: Flanged.
  - e. Trim: Bronze.
  - f. Packing and Gasket: Asbestos free.

## **2.12 CHAINWHEELS**

### **A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.**

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

## **PART 3 - EXECUTION**

### **3.1 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.



- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly gate and globe valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
  - 1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

### 3.2 ADJUSTING

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

### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball, butterfly, or gate valves.
  - 2. Throttling Service: , ball, or butterfly valves.
  - 3. Pump-Discharge Check Valves:
    - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
    - b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
    - c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 (DN 50) 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 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

### 3.4 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG (1035 kPa) OR LESS)

- A. Pipe NPS 2 (DN 50) and Smaller:
  - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.

2. Ball Valves: Two piece, full port, brass with brass trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.
4. Bronze Gate Valves: Class 125, NRS.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to NPS 100): May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, ductile-iron disc.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Iron Gate Valves: Class 125, NRS.

### 3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, nonmetallic disc.
3. Ball Valves: Two piece, full port, brass with brass trim.
4. Bronze Swing Check Valves: Class 125, nonmetallic disc.
5. Bronze Gate Valves: Class 125, NRS.
6. Bronze Globe Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to NPS 100): May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, ductile-iron disc.
3. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
5. Iron Gate Valves: Class 125, NRS.
6. Iron Globe Valves: Class 125.

### 3.6 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass with brass trim.
3. Bronze Swing Check Valves: Class 125, nonmetallic disc.
4. Bronze Gate Valves: Class 125, NRS.
5. Bronze Globe Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to NPS 100): May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
4. Iron Gate Valves: Class 125, NRS.
5. Iron Globe Valves: Class 125.

**END OF SECTION 22 0523**

**SECTION 22 0529****HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Thermal-hanger shield inserts.
  - 4. Fastener systems.
  - 5. Pipe positioning systems.
  - 6. Equipment supports.

**1.2 PERFORMANCE REQUIREMENTS**

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

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Trapeze pipe hangers.
  - 2. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Welding certificates.

**1.4 QUALITY ASSURANCE**

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

**PART 2 - PRODUCTS****2.1 METAL PIPE HANGERS AND SUPPORTS**

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
  - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe Hangers:
  - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
  - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

**2.2 TRAPEZE PIPE HANGERS**

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

**2.3 THERMAL-HANGER SHIELD INSERTS**

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.
- 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 (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## **2.4 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.

## **2.5 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.

## **2.6 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## **2.7 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 (34.5-MPa), 28-day compressive strength.

# **PART 3 - EXECUTION**

## **3.1 HANGER AND SUPPORT INSTALLATION**

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. 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.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) 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.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. 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 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
  - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
  - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
  - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
  - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) 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 (40 mm).

### **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 (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### **3.6 HANGER AND SUPPORT SCHEDULE**

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.



- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
  3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
  9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.
  7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or 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 22 0529**

**SECTION 22 0553****IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.

**1.2 SUBMITTAL**

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

**PART 2 - PRODUCTS****2.1 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  - 3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
  - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
  - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
  - 2. Letter Color: Black.
  - 3. Background Color: Yellow.
  - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- 7. Fasteners: Stainless-steel rivets or self-tapping screws.
- 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus 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, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. 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 partially cover 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, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

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

#### **3.2 EQUIPMENT LABEL INSTALLATION**

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

#### **3.3 PIPE LABEL INSTALLATION**

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section ". "
- B. 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 (15 m) Insert dimension along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
  1. Low-Pressure, Compressed-Air Piping:
    - a. Background Color: Black.
    - b. Letter Color: White.
  2. Medium-Pressure, Compressed-Air Piping:
    - a. Background Color: Black.
    - b. Letter Color: Yellow.
  3. Domestic Water Piping:

- a. Background Color: Black.
  - b. Letter Color: Blue.
- 4. Sanitary Waste and Storm Drainage Piping:
  - a. Background Color: Black.
  - b. Letter Color: Blue.

**END OF SECTION 22 0553**

**SECTION 22 0700****PLUMBING INSULATION****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Piping insulation.
- B. Jackets and accessories.

**1.2 REFERENCES**

- A. ASTM C195 - Mineral Fiber Thermal Insulation Cement.
- B. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- C. ASTM C547 - Mineral Fiber Preformed Pipe Insulation.
- D. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- E. ASTM E84 - Surface Burning Characteristics of Building Materials.
- F. ASTM E96 - Water Vapor Transmission of Materials.
- G. NFPA 255 - Surface Burning Characteristics of Building Materials.
- H. UL 723 - Surface Burning Characteristics of Building Materials.

**1.3 SUBMITTALS**

- A. Submit under provisions of Division 01.
- B. Product Data: Provide product description, list of materials and thickness for each service, and locations.
- C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

**1.4 QUALITY ASSURANCE**

- A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, UL 723.

**1.5 QUALIFICATIONS**

- A. Applicator: Company specializing in performing the work of this section with minimum five years documented experience.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, protect, and handle products to site under provisions of Section 15010 and Division 1.
- B. Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- C. Store insulation in original wrapping and protect from weather and construction traffic.
- D. Protect insulation against dirt, water, chemical, and mechanical damage.

**1.7 ENVIRONMENTAL REQUIREMENTS**

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

**PART 2 - PRODUCTS****2.1 ACCEPTABLE MANUFACTURERS**

- A. Manville Products Corp.
  - 1. Knauf Fiberglass.
  - 2. Owens-Corning.
  - 3. Certainteed Corp.
  - 4. PPG Industries.
  - 5. Armstrong Industries.
  - 6. Pittsburgh Corning Industries.

**2.2 INSULATION**

- A. Type A: ASTM C547; rigid molded, fiberglass, noncombustible.
  - 1. 'K' value: 0.24 at 75 degrees F.
  - 2. Minimum Service Temperature: -20 degrees F.
  - 3. Maximum Service Temperature: 650 degrees F.
  - 4. Maximum Moisture Absorption: 0.2 percent by volume.
- B. Type C; ASTM C534; flexible, cellular elastomeric, molded or sheet.
  - 1. 'K' Value: 0.30 at 75 degrees F.
  - 2. Minimum Service Temperature: -20 degrees F.
  - 3. Maximum Service Temperature: 220 degrees F.
  - 4. Maximum Moisture Absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
  - 5. Moisture Vapor Transmission: ASTM E96; 0.17 perm inches.
  - 6. Maximum Flame Spread: ASTM E84; 25.
  - 7. Maximum Smoke Developed: ASTM E84; 50.



8. Connection: Waterproof vapor barrier adhesive.
9. Adhesive: Air dried, contact adhesive, compatible with insulation.

### **2.3 VAPOR BARRIER JACKETS FOR GLASS FIBER INSULATION**

#### **A. Vapor Barrier Jacket, Interior Applications**

1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminumized film.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

### **2.4 JACKETS**

#### **A. PVC Plastic**

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, off white color.
2. Minimum Service Temperature: -40 degrees F
3. Maximum Service Temperature: 170 degrees F
4. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
5. Maximum Flame Spread: ASTM E84; 25.
  - a. Maximum Smoke Developed: ASTM E84; 50
  - b. Thickness: 10 mils (indoor); 20 mils outdoors.
  - c. Connections: For exterior applications, brush on welding adhesive. For interior application, pressure sensitive color matching vinyl tape.
  - d. Covering Adhesive Mastic
  - e. Compatible with insulation.

#### **B. Canvas Jacket: UL listed**

1. Fabric: ASTM C921, 6 oz/sq yd plain weave cotton treated with dilute fire retardant lagging adhesive.
2. Lagging Adhesive: Compatible with insulation.

### **2.5 ACCESSORIES**

- A. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.
- B. Vapor Barrier Lap Adhesive
  1. Compatible with insulation.
- C. Insulating Cement/Mastic
  1. ASTM C195; hydraulic setting on mineral wool.
- D. Fibrous Glass Fabric

1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
  2. Blanket: 1.0 lb/cu ft density.
- E. Indoor Vapor Barrier Finish
1. Vinyl emulsion type acrylic, compatible with insulation, white color.
- F. Insulating Cement
1. ASTM C449.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

#### **3.2 INSTALLATION**

- A. Install materials in accordance with manufacturer's instructions.
- B. On exposed piping, locate insulation and cover seams in least visible locations.
- C. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory applied or field applied.
  2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
  3. Finish with glass cloth and vapor barrier adhesive.
  4. PVC fitting covers may be used.
  5. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
  6. Insulate entire system including fittings, valves, unions, flanges, strainers, pump bodies, and expansion joints.
- D. For insulated pipes conveying fluids above ambient temperature:
1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
  2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
  3. Finish with glass cloth and adhesive.
  4. PVC fitting covers may be used.
  5. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
  6. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- E. Inserts and Shields:

1. Application: Piping 2-1/2 inches diameter or larger.
  2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  3. Insert Location: Between support shield and piping and under the finish jacket.
  4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  5. Insert Material: ASTM C640 cork or hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- F. Finish insulation at supports, protrusions, and interruptions.
- G. For pipe exposed in mechanical equipment rooms below 8 feet above finished floor, finish with PVC jacket and fitting covers.

### 3.3 INSULATION SCHEDULE

A.	PIPING SYSTEMS	PIPE SIZE (Inches)	TYPE	THICKNESS (Inches)
	Domestic Hot water Supply and Recirculation.	1/2 - 1 1-1/4 and over	A or C A	1/2 1
	Domestic Cold Water	1/2 - 1-1/2 2 and over	A or C A or C	1/2 1

**END OF SECTION 22 0700**



**SECTION 220800****COMMISSIONING OF PLUMBING****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes commissioning process requirements for Plumbing systems, assemblies, and equipment.
- B. Commissioning requires the participation of Division 22 to ensure that all systems are operating in a manner consistent with the Contract Documents.
- C. The contractor shall execute all commissioning responsibilities assigned to them described in Section 01 75 00 "General Commissioning Requirements", the Contract Documents, and in the Commissioning Plan issued by the CxA.

**1.2 DEFINITIONS**

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

**1.3 INFORMATIONAL SUBMITTALS**

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

**1.4 CONTRACTOR'S RESPONSIBILITIES**

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Participate in orientation and inspection for Plumbing systems, assemblies, equipment, and component maintenance as directed by the CxA.
- D. Provide approved submittals and information requested by the CxA for final commissioning documentation.
- E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

**1.5 CxA'S RESPONSIBILITIES**

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

**1.6 COMMISSIONING DOCUMENTATION**

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

**PART 2 - PRODUCTS**

- 2.1 Division 22 shall provide all test equipment necessary to fulfill the testing requirements of this Division.
- 2.2 Refer to Section 017500 for additional Division 22 requirements.

**PART 3 - EXECUTION****3.1 TESTING PREPARATION**

- A. Certify that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that Plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified on checklists.
- E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- F. Testing Instrumentation: Provide and install measuring instruments and logging devices to record test data as directed by the CxA.

**3.2 GENERAL TESTING REQUIREMENTS**

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Plumbing testing shall include entire Plumbing installation. Testing shall include measuring capacities and effectiveness of operational and control functions.

- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
  - D. The CxA along with the Plumbing Contractor shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
  - E. Tests will be performed using design conditions whenever possible.
  - F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
  - G. The CxA may direct that set points be altered when simulating conditions is not practical.
  - H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
  - I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
  - J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.
- 3.3 Plumbing systems and equipment Testing Procedures
- A. Provide submittals, test data, inspector record, and boiler certification to the CxA.
  - B. Plumbing Instrumentation and Control System Testing: Perform field testing following testing plans and requirements. Assist the CxA with preparation of testing plans.
  - C. Plumbing Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of domestic hot water distribution systems.

**3.4 EQUIPMENT AND ASSOCIATED SYSTEMS TO BE COMMISSIONED**

SECTION	SYSTEM DESCRIPTION	SAMPLING
223400	FUEL-FIRED, DOMESTIC WATER HEATERS	100%

**END OF SECTION 220800**





**SECTION 22 1116**  
**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 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Aboveground domestic water pipes, tubes, fittings, and specialties inside the building.

**1.3 SUBMITTALS**

- A. Product Data: For the following products:
  - 1. Specialty valves.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Field quality-control reports.

**1.4 QUALITY ASSURANCE**

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

**1.5 PROJECT 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 proceed with interruption of water service without Owner's written permission.

**1.6 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

**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 COPPER TUBE AND FITTINGS**

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
  - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
  - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
  - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
  - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

**2.3 PIPING 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 for general-duty brazing unless otherwise indicated.

**2.4 SPECIALTY VALVES**

- A. Comply with requirements in Division 15 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

**2.5 DIELECTRIC FITTINGS**

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
  - 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. Capitol Manufacturing Company.
- b. Central Plastics Company.
- c. EPCO Sales, Inc.
- d. Hart Industries International, Inc.
- e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:

- a. Pressure Rating: 150 psig (1035 kPa) at 180 deg F (82 deg C).
- b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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. Capitol Manufacturing Company.
- b. Central Plastics Company.
- c. EPCO Sales, Inc.
- d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Factory-fabricated, bolted, companion-flange assembly.
- b. Pressure Rating: 150 psig (1035 kPa).
- c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

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. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.

2. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: 150 psig (1035 kPa).
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

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. Calpico, Inc.
  - b. Lochinvar Corporation.
- 2. Description:
  - a. Galvanized-steel coupling.
  - b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
  - c. End Connections: Female threaded.
  - d. Lining: Inert and noncorrosive, thermoplastic.
- F. Dielectric Nipples:
  - 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. Perfection Corporation; a subsidiary of American Meter Company.
    - b. Precision Plumbing Products, Inc.
    - c. Victaulic Company.
  - 2. Description:
    - a. Electroplated steel nipple complying with ASTM F 1545.
    - b. Pressure Rating: 150 psig (1035 kPa).
    - c. End Connections: Male threaded or grooved.
    - d. Lining: Inert and noncorrosive, propylene.

## **PART 3 - EXECUTION**

### **3.1 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 immediately upstream of each dielectric fitting.
- C. Install domestic water piping with 0.25 percent slope downward toward drain and plumb.
- D. Install piping concealed from view and protected from physical contact by building occupants 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, and coordinate with other services occupying that space.
- G. Install piping adjacent to equipment and specialties to allow service and maintenance.
- H. Install piping to permit valve servicing.

- I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- M. Install thermostats in hot-water circulation piping.
- N. Install thermometers on outlet piping from each water heater.

### **3.2 JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### **3.3 VALVE INSTALLATION**

- A. General-Duty Valves: Comply with requirements in Division 15 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly or gate valves for piping NPS 2-1/2 (DN 65) and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 15 Section "Domestic Water Piping Specialties."
  - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.

2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 (DN 50) and smaller and butterfly valves for piping NPS 2-1/2 (DN 65) and larger. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for balancing valves.

### **3.4 TRANSITION FITTING INSTALLATION**

- A. Install transition couplings at joints of dissimilar piping.

### **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 (DN 50) and Smaller: Use dielectric couplings.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

### **3.6 FLEXIBLE CONNECTOR INSTALLATION**

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.

### **3.7 HANGER AND SUPPORT INSTALLATION**

- A. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
1. Vertical Piping: MSS Type 8 or 42, clamps.
  2. Individual, Straight, Horizontal Piping Runs:
    - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
  3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
  2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
  3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
  4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
  5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
  6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
  7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- E. Install supports for vertical copper tubing every 10 feet (3 m).

### 3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

### 3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 15 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
  2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

### 3.11 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 flow of hot water 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.

### 3.12 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 (50 mg/L) 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 (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. 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.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

### 3.13 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
  1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought- copper solder-joint fittings; and soldered joints.
- E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
  1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought- copper solder-joint fittings; and soldered joints.

**3.14 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 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
  - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
  - 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop 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 22 1116**

**SECTION 22 1119****DOMESTIC WATER PIPING SPECIALTIES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following domestic water piping specialties:
  - 1. Vacuum breakers.
  - 2. Backflow preventers.
  - 3. Strainers.
  - 4. Hose bibbs.
  - 5. Wall hydrants.
  - 6. Drain valves.
  - 7. Water hammer arresters.
  - 8. Trap-seal primer valves.
- B. See Division 22 Section "Domestic Water Piping" for water meters.
- C. See Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.
- D. See Division 22 Section "Domestic Water Filtration Equipment" for water filters in domestic water piping.

**1.2 PERFORMANCE REQUIREMENTS**

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

**1.4 QUALITY ASSURANCE**

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

**PART 2 - PRODUCTS****A. Hose-Connection Vacuum Breakers:**

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Arrowhead Brass Products, Inc.
  - b. Cash Acme.
  - c. Conbraco Industries, Inc.
  - d. Legend Valve.
  - e. MIFAB, Inc.
  - f. Prier Products, Inc.
  - g. Watts Industries, Inc.; Water Products Div.
  - h. Woodford Manufacturing Company.
  - i. Zurn Plumbing Products Group; Light Commercial Operation.
  - j. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

**B. Reduced-Pressure-Principle Backflow Preventers:**

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Ames Co.
  - b. Conbraco Industries, Inc.
  - c. FEBCO; SPX Valves & Controls.
  - d. Flomatic Corporation.
  - e. Watts Industries, Inc.; Water Products Div.
  - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1 (DN25)
5. Design Flow Rate: 10gpm (.63L/S)
6. Selected Unit Flow Range Limits: 20 gpm (1.26 L/S)
7. Pressure Loss at Design Flow Rate: 13 psig (90 kPa) for sizes NPS 2 (DN 50) and smaller; for NPS 2-1/2 (DN 65) and larger.
8. Body: Bronze for NPS 2 (DN 50) and smaller; steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
9. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
10. Configuration: Designed for horizontal, straight through flow.
11. Accessories:
  - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
  - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

## C. Backflow-Preventer Test Kits:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Conbraco Industries, Inc.
  - b. FEBCO; SPX Valves & Controls.
  - c. Flomatic Corporation.
  - d. Watts Industries, Inc.; Water Products Div.
  - e. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

**2.2 STRAINERS FOR DOMESTIC WATER PIPING**

## A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
  - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm) 0.033 inch (0.84 mm) 0.062 inch (1.57 mm).
  - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm) 0.062 inch (1.57 mm) 0.125 inch (3.18 mm).
  - c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm) 0.125 inch (3.18 mm) 0.25 inch (6.35 mm).
6. Drain: Factory-installed, hose-end drain valve.

**2.3 HOSE BIBBS**

## A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.

12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating hose bibb.
15. Include integral wall flange with each chrome or nickel-plated hose bibb.

## **2.4 WALL HYDRANTS**

### **A. Nonfreeze Wall Hydrants:**

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Josam Company.
  - b. MIFAB, Inc.
  - c. Prier Products, Inc.
  - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - e. Tyler Pipe; Wade Div.
  - f. Watts Drainage Products Inc.
  - g. Woodford Manufacturing Company.
  - h. Zurn Plumbing Products Group; Light Commercial Operation.
  - i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 (DN 20).
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: rough bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: rough bronze.
12. Operating Keys(s): Two with each wall hydrant.

## **2.5 DRAIN VALVES**

### **A. Ball-Valve-Type, Hose-End Drain Valves:**

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

**2.6 WATER HAMMER ARRESTERS****A. Water Hammer Arresters:**

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. following:
  - a. AMTROL, Inc.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. PPP Inc.
  - e. Sioux Chief Manufacturing Company, Inc.
  - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - g. Tyler Pipe; Wade Div.
  - h. Watts Drainage Products Inc.
  - i. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Standard: ASSE 1010 or PDI-WH 201.
4. Type: Metal bellows.
5. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

**2.7 TRAP-SEAL PRIMER VALVES****A. Supply-Type, Trap-Seal Primer Valves:**

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. MIFAB, Inc.
  - b. PPP Inc.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - e. Watts Industries, Inc.; Water Products Div.
3. Standard: ASSE 1018.
4. Pressure Rating: 125 psig (860 kPa) minimum.
5. Body: Bronze.
6. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
7. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Locate backflow preventers in same room as connected equipment or system.
  - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
  - 3. Do not install bypass piping around backflow preventers.
- C. Install Y-pattern strainers for water on supply side of backflow preventer, if not part of assembly.
- D. Install water hammer arresters in water piping according to PDI-WH 201.
- E. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- F. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- G. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Intermediate atmospheric-vent backflow preventers.
  - 2. Reduced-pressure-principle backflow preventers.
  - 3. Double-check backflow-prevention assemblies.
  - 4. Water pressure-reducing valves.
  - 5. Primary, thermostatic, water mixing valves.
  - 6. Supply-type, trap-seal primer valves.
- H. 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 Division 22 Section "Identification for Plumbing Piping and Equipment."

### **3.2 FIELD QUALITY CONTROL**

- A. Perform the following tests and prepare test reports:
  - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

**END OF SECTION 22 1119**



**SECTION 22 1316****SANITARY WASTE AND VENT PIPING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:
  - 1. Pipe, tube, and fittings.
  - 2. Special pipe fittings.
- B. See Division 22 Section "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

**1.2 PERFORMANCE REQUIREMENTS**

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

**1.3 SUBMITTALS**

- A. LEED Submittal:
  - 1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
- B. Field quality-control inspection and test reports.

**1.4 QUALITY ASSURANCE**

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 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-drain" for plastic drain piping.

**PART 2 - PRODUCTS****2.1 PIPING MATERIALS**

- A. Hub-and-Spigot, Cast-Iron Pipe and Fittings: ASTM A 74, Service class.

1. Gaskets: ASTM C 564, rubber.
- B. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.
  1. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
    - a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
    - b. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
- C. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.
  1. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
  2. Pressure Fittings:
    - a. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
    - b. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
    - c. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, **[galvanized, ]**standard pattern.
    - d. Cast-Iron Flanges: ASME B16.1, Class 125.
    - e. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.
- D. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
  1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought-copper, solder-joint fittings.
- E. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40, solid wall.
  1. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
  2. Solvent Cement and Adhesive Primer:
    - a. Use ABS solvent cement that has a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solid-Wall PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.
  1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
  2. Solvent Cement and Adhesive Primer:
    - a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

**PART 3 - EXECUTION****3.1 PIPING APPLICATIONS**

- A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- C. Aboveground, soil, waste, and vent piping NPS 4 (DN 100) and smaller Insert pipe size range shall be any of the following:
  - 1. joints.
  - 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
  - 3. Steel pipe, drainage fittings, and threaded joints.
  - 4. Copper DWV tube, copper drainage fittings, and soldered joints.
  - 5. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
  - 6. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Aboveground, soil, waste, and vent piping NPS 5 (DN 125) and larger shall be any of the following:
  - 1. Hubless cast-iron soil pipe and fittings and solvent stack fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
  - 2. Steel pipe, drainage fittings, and threaded joints.
  - 3. Copper DWV tube, copper drainage fittings, and soldered joints.
  - 4. Cellular-core Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
  - 5. Cellular-core Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- E. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:
  - 1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
  - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- F. Underground, soil and waste Piping NPS 5 (DN 125) and larger shall be any of the following:
  - 1. Service class, hub and spigot cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. ABS pipe, ABS socket fittings, and solvent-cemented joints.
  - 3. Cellular-core ABS pipe, ABS socket fittings, and solvent-cemented joints.
  - 4. Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.

**3.2 PIPING INSTALLATION**

- A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- E. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 22 Section "Common Work Results for Plumbing."
- F. 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."
- G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- H. 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.
- I. 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 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) 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.
- J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- K. Install ABS soil and waste drainage and vent piping according to ASTM D 2661.
- L. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- M. Install underground ABS and PVC soil and waste drainage piping according to ASTM D 2321.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

**3.3 JOINT CONSTRUCTION**

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
  - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

**3.4 VALVE INSTALLATION**

- A. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
  - 1. Use gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
  - 2. Use gate valve for piping NPS 2-1/2 (DN 65) and larger.
- C. Check Valves: Install swing check valve, downstream from shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
  - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
  - 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
  - 3. Install backwater valves in accessible locations.
  - 4. Backwater valves are specified in Division 22 Section "Sanitary Waste Piping Specialties."

**3.5 HANGER AND SUPPORT INSTALLATION**

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
  - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
    - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
  2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
  3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
  4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
  5. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).
- G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
  2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
  3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
  4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
  5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
  6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
  7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
- I. Install supports for vertical steel piping every 15 feet (4.5 m).
- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
  2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
  3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
  4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
  5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
- K. Install supports for vertical copper tubing every 10 feet (3 m).
- L. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
  2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
  3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
  4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
- M. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).
- N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### **3.6 CONNECTIONS**

- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
  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. 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 (DN 65) and larger.

### **3.7 FIELD QUALITY CONTROL**

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.
1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  2. Prepare reports for tests and required corrective action.

**3.8 CLEANING**

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

**3.9 PROTECTION**

- A. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

**END OF SECTION 22 1316**



**SECTION 22 1319****SANITARY WASTE PIPING SPECIALTIES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Miscellaneous sanitary drainage piping specialties.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

**1.3 QUALITY ASSURANCE**

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

**PART 2 - PRODUCTS****2.1 BACKWATER VALVES**

- A. Horizontal, Cast-Iron Backwater Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Josam Company; Josam Div.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
  - d. Tyler Pipe; Wade Div.
  - e. Watts Drainage Products Inc.
  - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted access check valve.
6. End Connections: Hub and spigot.

7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company; Josam Div.
  - b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
  - c. Watts Drainage Products Inc.
  - d. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Size: Same as floor drain outlet.
4. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
5. Check Valve: Removable ball float.
6. Inlet: Threaded.
7. Outlet: Threaded or spigot.

## 2.2 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Josam Company; Josam Div.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - d. Tyler Pipe; Wade Div.
  - e. Watts Drainage Products Inc.
  - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M 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, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Josam Company; Josam Div.
  - b. Oatey.

- c. Sioux Chief Manufacturing Company, Inc.
  - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - e. Tyler Pipe; Wade Div.
  - f. Watts Drainage Products Inc.
  - g. Zurn Plumbing Products Group; Light Commercial Operation.
  - h. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.
  - 3. Size: Same as connected branch.
  - 4. Type: Cast-iron soil pipe with cast-iron ferrule.
  - 5. Body or Ferrule: Cast iron.
  - 6. Clamping Device: Not required.
  - 7. Outlet Connection: Inside calk.
  - 8. Closure: Brass plug with straight threads and gasket Cast-iron plug.
  - 9. Adjustable Housing Material: Cast iron with threads.
  - 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
  - 11. Frame and Cover Shape: Round.
  - 12. Top Loading Classification: Medium Duty.
  - 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Josam Company; Josam Div.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - d. Tyler Pipe; Wade Div.
  - e. Watts Drainage Products Inc.
  - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M. Include wall access.
- 3. Size: Same as connected drainage piping.
- 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk, 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.
- 8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

## 2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Commercial Enameling Co.
  - b. Josam Company; Josam Div.
  - c. MIFAB, Inc.
  - d. Prier Products, Inc.

- e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
  - f. Tyler Pipe; Wade Div.
  - g. Watts Drainage Products Inc.
  - h. Zurn Plumbing Products Group; Light Commercial Operation.
  - i. 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: Not required.
  - 6. Anchor Flange: Not required.
  - 7. Clamping Device: Not required.
  - 8. Outlet: Bottom.
  - 9. Backwater Valve: Not required.
  - 10. Coating on Interior and Exposed Exterior Surfaces: Not required.
  - 11. Sediment Bucket: Cast iron slotted with lift bar.
  - 12. Top or Strainer Material: Nickel bronze.
  - 13. Top of Body and Strainer Finish: Nickel bronze.
  - 14. Top Shape: Round.
  - 15. Dimensions of Top or Strainer: 8 ½+ Nickel Bronze for (Bathrooms), 8 ½+ Ductile Iron (Mechanical Rooms).
  - 16. Top Loading Classification: Medium Duty.
  - 17. Funnel: Required
  - 18. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
  - 19. Trap Material: Cast iron.
  - 20. Trap Pattern: Standard P-trap.
  - 21. Trap Features: Trap-seal primer valve drain connection.

## **2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES**

- a. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.
- 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 (DN 15) side inlet.
- C. 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.
- D. 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 (25 mm) 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.
- E. 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.
- F. 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.

## **2.5 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. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
  2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
  3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. 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 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
  4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install 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 (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) 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.
- G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- 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 grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
  2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
  3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.

4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

### **3.2 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

### **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. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
- 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 (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
  2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
  3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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 Division 07 Section "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.

**3.4 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

**3.5 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 22 1319**



**SECTION 22 1413**  
**STORM DRAINAGE PIPING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Pipe, tube, and fittings.
  - 2. Specialty pipe fittings.
- B. Related Section:
  - 1. Division 33 Section "Storm Utility Drainage Piping" for storm drainage piping outside the building.

**1.2 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. LEED Submittal:
  - 1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
- C. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.
- D. Field quality-control reports.

**1.4 QUALITY ASSURANCE**

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

**PART 2 - PRODUCTS****2.1 PIPING MATERIALS**

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

**2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

**2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
  - 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. ANACO-Husky.
    - b. Dallas Specialty & Mfg. Co.
    - c. Fernco Inc.
    - d. Matco-Norca, Inc.
    - e. MIFAB, Inc.
    - f. Mission Rubber Company; a division of MCP Industries, Inc.
    - g. Stant.
    - h. Tyler Pipe.
  - 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.

**2.4 COPPER TUBE AND FITTINGS**

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.
- C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
  - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
  - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

**2.5 ABS PIPE AND FITTINGS**

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
- C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
- D. Solvent Cement: ASTM D 2235.
  - 1. Use ABS solvent cement that has a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

**2.6 PVC PIPE AND FITTINGS**

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
  - 1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Solvent Cement: ASTM D 2564.
  - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

**2.7 SPECIALTY PIPE FITTINGS**

- A. Transition Couplings:
  - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
  - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
  - 3. Unshielded, Nonpressure Transition Couplings:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Dallas Specialty & Mfg. Co.
      - 2) Fernco Inc.
      - 3) Mission Rubber Company; a division of MCP Industries, Inc.
      - 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
    - b. Standard: ASTM C 1173.

- c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - d. Sleeve Materials:
    - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
    - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Shielded, Nonpressure Transition Couplings:
- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) Cascade Waterworks Mfg. Co.
    - 2) Mission Rubber Company; a division of MCP Industries, Inc.
  - b. Standard: ASTM C 1460.
  - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

## **PART 3 - EXECUTION**

### **3.1 EARTH MOVING**

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

### **3.2 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.

- H. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- K. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Storm Drain: 1 percent downward in direction of flow for piping **NPS 3 (DN 80)** and smaller; 1 percent downward in direction of flow for piping **NPS 4 (DN 100)** and larger.
  - 2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.
- L. 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.
- M. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- N. Install aboveground ABS piping according to ASTM D 2661.
- O. Install aboveground PVC piping according to ASTM D 2665.
- P. Install underground PVC piping according to ASTM D 2321.
- Q. Plumbing Specialties:
  - 1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Storm Drainage Piping Specialties."
  - 2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Storm Drainage Piping Specialties."
  - 3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Storm Drainage 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 Division 22 Section "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 Division 22 Section "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 Division 22 Section "Escutcheons for Plumbing Piping."

### **3.3 JOINT CONSTRUCTION**

- A. Join hub-and-spigot, cast-iron soil piping with gasketed 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. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

### **3.4 SPECIALTY PIPE FITTING INSTALLATION**

- A. Transition Couplings:
  - 1. Install transition couplings at joints of piping with small differences in OD's.
  - 2. In Drainage Piping: Shielded, nonpressure transition couplings.

### **3.5 HANGER AND SUPPORT INSTALLATION**

- A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
  - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
  - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
  - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
  - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
  - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
  - 6. Individual, Straight, Horizontal Piping Runs:

- a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
  - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
  - c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
  2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
  3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
  4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
  5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
  6. Spacing for 10-foot (3-m) pipe lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).
- G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
  2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
  3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
  4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
  5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
  6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- I. Install supports for vertical copper tubing every 10 feet (3 m).
- J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
  2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
  3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
  4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.

5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
- K. Install supports for vertical PVC piping every 48 inches (1200 mm).
- L. 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 interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
  1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

### **3.7 IDENTIFICATION**

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "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.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.



3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

### **3.9 CLEANING**

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### **3.10 PIPING SCHEDULE**

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
  1. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
  2. Copper DWV tube, copper drainage fittings, and soldered joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- C. Underground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
  1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

**END OF SECTION 22 1413**



**SECTION 22 1423****STORM DRAINAGE PIPING SPECIALTIES****1.1 GENERAL**

- A. Section Includes:
1. Roof drains.
  2. Miscellaneous storm drainage piping specialties.
  3. Cleanouts.
  4. Flashing materials.

**1.2 SUBMITTALS**

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

**1.3 QUALITY ASSURANCE**

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

**PART 2 - PRODUCTS****2.1 METAL ROOF DRAINS**

- A. Cast-Iron, Medium-Sump, General-Purpose Roof Drains R.D. and R.O.D:
1. Standard: ASME A112.6.4, for general-purpose roof drains.
  2. Body Material: Cast iron.
  3. Dimension of Body: 8- to 12-inch (203- to 305-mm) diameter.
  4. Combination Flashing Ring and Gravel Stop: Required.
  5. Flow-Control Weirs: Required.
  6. Outlet: Bottom.
  7. Extension Collars: Required.
  8. Underdeck Clamp: Required.
  9. Expansion Joint: Not required.
  10. Sump Receiver Plate: Required.
  11. Dome Material: Cast iron.
  12. Wire Mesh: Not required.
  13. Perforated Gravel Guard: Not required.
  14. Vandal-Proof Dome: Not required.
  15. Water Dam: Not required.

**2.2 CLEANOUTS**

- A. Floor Cleanouts:

1. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule Material: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Inside calk.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy. Frame and Cover Shape: Round.
10. Top-Loading Classification: Medium Duty.
11. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees:

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug: Countersunk or raised head,.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts:

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, cast-iron plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, wall-installation frame and cover.

## 2.3 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 Sections.
  - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
  - 2. Install expansion joints, if indicated, in roof drain outlets.
  - 3. Position roof drains for easy access and maintenance.
- B. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
  - 1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
  - 3. Locate cleanouts at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
  - 4. Locate cleanouts at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install horizontal backwater valves in floor with cover flush with floor.
- F. Install test tees in vertical conductors and near floor.
- G. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- H. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- I. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

**3.2 CONNECTIONS**

- A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

**3.3 FLASHING INSTALLATION**

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. (30-kg/sq. m) lead sheets, 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of 4.0-lb/sq. ft. (20-kg/sq. m) lead sheets, 0.0625-inch (1.6-mm) 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 the pipe size, with a minimum length of 10 inches (250 mm) and with skirt or flange extending at least 8 inches (200 mm) around pipe.
  2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
  3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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. Fabricate and install flashing and pans, sumps, and other drainage shapes.

### **3.4 PROTECTION**

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 1423**

**SECTION 22 3400****FUEL-FIRED, DOMESTIC-WATER HEATERS****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. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
  - 2. Domestic-water heater accessories.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

**1.4 SUBMITTALS**

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittal:
  - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
- C. Shop Drawings:
  - 1. Wiring Diagrams: For power, signal, and control wiring.
- D. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of commercial, gas-fired, domestic-water heater, from manufacturer.
- F. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- G. Source quality-control reports.
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.
- J. Warranty: Sample of special warranty.

### **1.5 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA 90.1 Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
  1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

### **1.6 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

### **1.7 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Structural failures including storage tank and supports.
    - b. Faulty operation of controls.



- c. Deterioration of metals, metal finishes, and other materials beyond normal use.
- 2. Warranty Periods: From date of Substantial Completion.
  - a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
    - 1) Storage Tank: Five years.
    - 2) Controls and Other Components: One year(s).

## **PART 2 - PRODUCTS**

### **2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS**

- A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide a product indicated on Drawings or comparable product by one of the following:
    - a. AERCO International, Inc.
    - b. Ajax Boiler Inc.
    - c. American Water Heaters.
    - d. Bradford White Corporation.
    - e. Heat Transfer Products, Inc.
    - f. Lochinvar Corporation.
    - g. PVI Industries, LLC.
    - h. RBI Water Heaters; a Mestek company.
    - i. Rheem Manufacturing Company.
    - j. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
    - k. State Industries.
    - l. Weben-Jarco, Inc.
  - 2. Standard: ANSI Z21.10.3/CSA 4.3.
  - 3. Description: Manufacturer's proprietary design to provide at least 94 percent combustion efficiency at optimum operating conditions.
  - 4. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) minimum working-pressure rating.
    - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      - 1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      - 2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
    - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    - c. Lining: Polymer complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
  - 5. Factory-Installed Storage-Tank Appurtenances:
    - a. Dip Tube: Required unless cold-water inlet is near bottom of tank.

- b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
- c. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
- d. Jacket: Steel with enameled finish.
- e. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
- f. Temperature Control: Adjustable thermostat.
- g. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
- h. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

B. Capacity and Characteristics:

- 1. Capacity: 250 gal. (946 (L)
- 2. Recovery: 450 gph (.47L/s) at 100 deg F (56 deg C) temperature rise.
- 3. Temperature Setting: 140 deg F (60 deg C).
- 4. Fuel Gas Input: 399,000 Btu/h (116831w).
- 5. Gas Pressure Regulator:
  - a. Capacity: 399 cfh (3.14L/s).
  - b. Inlet Pressure: 14 inches (355.6 mm) water column.
  - c. Gas Pressure Required at Burner: 4 ½ inches water column.
- 6. Electrical Characteristics:
  - a. Volts: 120.
  - b. Phase: Single.
  - c. Hertz: 60.
- 7. Minimum Vent Diameter: 6 inches

## 2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide a product indicated on Drawings or comparable product by one of the following:
  - a. AMTROL Inc.
  - b. Flexcon Industries.
  - c. Honeywell International Inc.
  - d. Pentair Pump Group (The); Myers.
  - e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
  - f. State Industries.
  - g. Taco, Inc.

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
  3. Construction:
    - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    - c. Air-Charging Valve: Factory installed.
  4. Capacity and Characteristics:
    - a. Working-Pressure Rating: 150 psig (1035 kPa).
    - b. Capacity Acceptable: 4 gal. (15.1 L) minimum.
    - c. Air Precharge Pressure: 80 psig (551.58 kPa).
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- D. Heat-Trap Fittings: ASHRAE 90.2.
- E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and memory-stop balancing valves to provide balanced flow through each domestic-water heater.
1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
  2. Comply with requirements for balancing valves specified in Division 22 Section "Domestic Water Piping Specialties."
- F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
- G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 2-psig (13.8-kPa) pressure rating as required to match gas supply.
- H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
  2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
- J. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
  2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
- K. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
- L. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.
- M. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

### 2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
  2. Maintain manufacturer's recommended clearances.
  3. Arrange units so controls and devices that require servicing are accessible.
  4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  7. Install anchor bolts to elevations required for proper attachment to supported equipment.
  8. Anchor domestic-water heaters to substrate.
- B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
  1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
  2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
  3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
  4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Division 23 Section "Facility Natural-Gas Piping."
- D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."
- G. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- H. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- I. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- J. Fill domestic-water heaters with water.
- K. Charge domestic-water compression tanks with air.

### 3.2 CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping."

- B. Comply with requirements for gas piping specified in Division 23 Section "Facility Natural-Gas Piping."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

### **3.3 IDENTIFICATION**

- A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

### **3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

### **3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

**END OF SECTION 22 3400**

**SECTION 22 4000**  
**PLUMBING FIXTURES**

**PART 1 GENERAL**

**1.1 WORK INCLUDED**

- A. Water Closets
- B. Urinals
- C. Lavatories
- D. Sinks
- E. Showers
- F. Laundry Tub
- G. Washer Box
- H. Mop Basin
- I. Water Cooler
- J. Safety Station

**1.2 REFERENCES**

- A. ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- C. ASME A112.19.2 - Vitreous China Plumbing Fixtures.
- D. ASME A112.19.3M . Stainless Steel Sinks.
- E. ASME A112.19.4 - Porcelain Enameled Formed steel Plumbing Fixtures.
- F. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards).

**1.3 SUBMITTALS**

- A. Submit under provisions of Division 1.
- B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. LEED Submittal:

Product Data for LEED Credit WE 3.2. Provide documentation indicating flow and water consumption requirements.

#### **1.4 OPERATION AND MAINTENANCE DATA**

- A. Submit under provisions of Division 1.
- B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, protect and handle products to site under provisions of Division 1.
- B. Accept fixtures on site in factory packaging. Inspect for damage.
- C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

#### **1.6 FIELD MEASUREMENTS**

- A. Verify that field measurements are as instructed by the manufacturer.
- B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

#### **1.7 EXTRA MATERIALS**

- A. Furnish under provisions of Division 1.
- B. Provide two of faucet washers and flush valve service kits.

### **PART 2 PRODUCTS**

#### **2.1 ACCEPTABLE MANUFACTURERS – VITREOUS CHINA FIXTURES**

- A. American Standard
- B. Kohler
- C. Eljer
- D. Substitution: Under provisions of Division 1.

#### **2.2 ACCEPTABLE MANUFACTURERS – STAINLESS STEEL SINKS**

- A. Elkay
- B. Just
- C. Moen
- D. Substitution: Under provisions of Division 1.

#### **2.3 ACCEPTABLE MANUFACTURERS - FIXTURE TRIM**



- A. American Standard
- B. Kohler
- C. Sloan
- D. Substitution: Under provisions of Division 1.

**2.4 ACCEPTABLE MANUFACTURERS - FLUSH VALVES**

- A. Sloan
- B. Zurn
- C. Delaney
- D. Substitution: Under provisions of Division 1.

**2.5 ACCEPTABLE MANUFACTURERS - WATER CLOSET SEATS**

- A. Church.
- B. Olsonite
- C. Bencke
- D. Substitution: Under provisions of Division 1.

**2.6 ACCEPTABLE MANUFACTURES - FIXTURE CARRIERS**

- A. J.R. Smith
- B. Wade
- C. Josam
- D. Substitutions: Under provisions of Division 1.

**2.7 PLUMBING FIXTURES:**

- A. Water Closet (P-1) (ADA Compliant)
  - 1. Bowl: ASME A112.19.2; floor mounted with top of rim 16-1/2 inches from floor level, bottom outlet, siphon jet vitreous china bowl with elongated rim, 1½ inch top spud, 10+or 12+rough-in, china bolt caps. Model 3043.001 manufactured by American Standard.
  - 2. Flush Valve: ASME A112.18.1; exposed chrome plated, sensor operated, (1.28 gpf). Model 111-1.28 ES-S TMO manufactured by Sloan
  - 3. Seat: 1-inch overall thickness with bumper solid white chip resistant polypropylene, open front, no cover, check hinge, brass bolts. Model 5901.100 manufactured by American Standard.
  - 4. Total overall height from floor to top of seat will be 17-1/2 inches.

## B. Urinal (P-2)

1. Bowl: ASME A112.19.2; vitreous china, wall hung washout urinal with integral trap, ¾ inch top spud .125 gallon per flush. Model 6590.001 manufactured by American Standard.
2. Flush Valve: ASME A112.18.1; exposed chrome plated, sensor operated flush operation (.125 gpf). Model 186-0.125 manufactured by Sloan.
3. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger and bearing studs.

## C. Urinal (P-2A) (ADA Compliant)

1. Bowl: ASME A112.19.2; vitreous china, wall hung washout urinal with integral trap, ¾ inch top spud .125 gallon per flush. Model 6590.001 manufactured by American Standard.
2. Flush Valve: ASME A112.18.1; exposed chrome plated, sensor operated flush operation (.125 gpf). Model 186-0.125 manufactured by Sloan.
3. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger and bearing studs.

## D. Lavatory (P-3) (ADA Compliant)

1. Basin: ASME A112.19.2; countertop mounted, self-rimming, vitreous china, front overflow, ledge-back, overall dimension 23-1/2"x 18-3/8", drilled for 8" centers. Model 0478.803 manufactured by American Standard.
2. Trim: ASME A112.18.1; Chrome plated brass supply, .5 gpm faucet with wristblades and pop-up drain. Model 6501.175 manufactured by American Standard.
3. Insulation: Provide flexible vinyl insulation kit on P-trap, cold and hot water supplies. Model 102E-Z manufactured by Truebro.
4. Trap Primer: Under-lav trap primer assembly connected to the cold water supply service stop. Model Pro1-ULP500 manufactured by Precision Plumbing Products. (To be provided on closest to floor drain).

## E. Lavatory (P-3A) (ADA Compliant)

1. Basin: ASME A112.19.2; wall mounted, vitreous china, rear overflow, overall dimensions 21-1/4"x 20.5", concealed arm support, drilled for centerset faucet. Model 0954.004EC w/0062.020EC shroud manufactured by American Standard.
2. Trim: ASME A112.18.1; chrome plated brass supply, .5 gpm aerator, sensor operated faucet with below deck thermostatic mixing valve. Model EFT-80-4 manufactured by Sloan.

3. Insulation: Provide flexible vinyl insulation kit on P-trap, cold and hot water supplies. Model 102E-Z manufactured by Truebro.

4. Trap Primer: Same as P-3.

F. Sink (P-4)

1. Bowl: Two separate ASME A112.19.3; single compartment, 23-1/2 x 21-1/8 x 9+inch outside dimensions, 18 gauge thick, type 304 stainless steel, self rimming with undercoating, ledge back drilled for trim. Model DXUH21189 manufactured by Elkay.
2. Trim: ASME A112.18.1; chrome plated brass supply with basket strainers, single lever handle, chrome plated 17 gauge 1-1/2 x 1-1/2 brass p-trap with cleanout plug and single handle pre-rinse kitchen faucet with braided stainless steel supply lines, stainless steel coil hand spray hose with spring spout, 3 function hand spray (aerated, spray, pause), Left compartment to be provided with cup strainer. Model LKAV4061CR manufactured by Elkay.

G. Sink (P-4A)

1. Bowl: ASME A119.3; double compartment, 33 x 22 x 9 inch outside dimensions, 18 gauge thick, type 304 stainless steel, self rimming with undercoating, ledge-back drilled for trim. Model ECTSR33229BG manufactured by Elkay.
2. Trim: ASME A112.18.1; chrome plated brass supply with grid strainers, swivel gooseneck spout, 4 inch chrome wrist blade handles, chrome plated 17 gauge 1-1/2 x 1-1/2 inch brass p-trap with cleanout plug and arm with escutcheon. Model J-1174-KS manufactured by Just Manufacturing Company.

H. Sink (P-4B)

1. Bowl: ASME A112.19.3; single compartment, 22 x 19-1/2 x ~~6 7-5/8~~ inch outside dimensions 18 gauge thick, type 304 stainless steel, self rimming with undercoating, ledge back drilled for trim. Model LRAD2219 manufactured by Elkay.
2. Trim: ASME A112.18.1; chrome plated brass supply with grid strainer, swivel goose-neck spout, 4+chrome wristblade handles, chrome plated 17 gauge 1-1/2 x 1-1/2 inch brass p-trap with cleanout plug and arm with escutcheon. Model J-1174-KS manufactured by Just Manufacturing Company.

I. Sink (P-4C)

1. Bowl: 36+semi-circular terrazzo consisting of 85% stone and 15% binder with steel reinforcing rods cast into the bowl. Polished and sealed with urethane resin.
2. Pedestal: constructed of die-formed legs, upper braces, scuff bases and panels, legs are zinc chromate plated 14 gauge steel, upper braces are 16 gauge galvanized steel, scuff bases and pedestal panels are 300 series stainless steel with a #4 finish.
3. Foot Control: foot rail mechanically actuates a hold open valve with slow closing upon release of foot pressure.
4. Components: Drain type ~~B~~+centrally rising vent with supplies from above, standard height pedestal, foot control valve for water activation, liquid soap dispenser, whisper gray color, thermostatic mixing valve for tempered water, stainless steel shroud to

conceal overhead piping and (2) C-fold multi-fold paper towel dispenser. Model WF2603 manufactured by Bradley.

J. Shower (P-5)

1. Base: Tile on a depressed slab. See architectural plans for details.
2. Trim: ANSI A112.18.1; concealed shower supply with pressure balanced mixing valve and built in limit stops, polished chrome wall flange and lever handle, color coded dial, self-cleaning 1.5 gpm shower head with non-removable flow compensator. Model Aquatrol 4500 w/ H14 fixed shower head manufactured by Leonard.

K. Shower (P-5A) (ADA Compliant)

1. Base: Tile on a depressed slab. See architectural plans for details.
2. Trim: ANSI A112.18.1; concealed shower supply with pressure balanced mixing valve and built-in limit stops, polished chrome wall flange and lever handle, color coded dial, self-cleaning 1.5 gpm showerhead with non-removable flow compensator, 69 inch braided stainless steel flex hose and 24 inch slide bar. Model Aquatrol 4500 w/ 515P hand shower manufactured by Leonard.

L. Laundry Tub (P-6)

1. Fixture: Floor mounted with baked enamel steel angle legs with leveling feet, 20 gallon capacity single compartment, constructed from structural foam, chrome plated brass supply deck faucet with 4 inch blade handles. Model TATI w/ 02883906000 and 02883900100 hardware kits manufactured by Fiat.

M. Washer Box (P-7)

1. Recessed 20 gauge steel box with corrosion resistant epoxy finish, 2 inch standpipe, (2) ½ inch water connections entering from top and water hammer arresters. Model 82049 manufactured by Guy Gray.

N. Commercial 30# Extractor Connection (P-7A)

1. Hose Bibb: ANSI/ASSE 1019: brass construction, adjustable packing nut with deep stem guard, Teflon impregnated packing and standard ¾" size washer, chrome plated brass exterior with chrome plated vacuum breaker conforming to ASSE 1011 with stem lock. Basis of Design: Woodford Model 24P ¾ inch outlet (2 required).
2. Water Hammer Arrester: ASSE 1010; sized in accordance with PDI WH-201, pre-charged suitable for operation in temperature range -100 to 300 degrees F (-73 to 149 degrees C) and maximum 250 psig (1700 kPa) working pressure. ¾ inch female hose coupling inlet and ¾ inch male hose fitting outlet. Basis of Design: Precision Plumbing Products, Inc. Model WHA-500L (2 required).

O. Mop Basin (P-8)

1. Bowl: 36 x 24 x 10 inch high molded stone, floor mounted with 1 inch wide shoulder. Model MSB3624 manufactured by Fiat Products.
2. Trim: ASME A112.18.1; exposed wall type supply lever handles, spout, wall brace, vacuum breaker, hose end spout, built in service stops and wall flanges. Model 830-AA manufactured by Fiat Products.

## 3. Accessories:

- a. Hose and Hose Holder: Reinforced heavy duty 5/8 inch diameter, 31 inch rubber hose with brass couplings on one end. Spring loaded, molded rubber hose holder mounts on stainless steel wall plate with all hardware. Model 832-AA manufactured by Fiat Products.
- b. Mop Hanger: Three spring-loaded, molded rubber mop holders attached to 3 x 24 inch stainless steel wall plate with all hardware. Model 889-CC manufactured by Fiat Products.
- c. Bumper Guards: Hi-impact, rigid vinyl for basin edge protection. Model E-77-AA manufactured by Fiat Products.
- d. Stainless Steel Wall Guard. Model MSG3624

## P. Mop Basin (P-8A)

1. Bowl: 34 x 34 x 10 inch high 18 gauge 304 stainless steel body, 16 gauge 304 stainless steel bowl, 3-1/2 inch drain opening. Model SMOPSI-3434 manufactured by Amtekco.
2. Trim: ASME A112.18.1; exposed wall type supply lever handles, spout, wall brace, vacuum breaker, hose end spout, built in service stops and wall flanges. Model K778106-BR manufactured by Amtekco.
3. Accessories:
  - a. Hose and Hose Holder: reinforced heavy duty 5/8 inch diameter, 36 inch rubber hose with brass couplings on one end. Spring loaded, molded rubber hose holder mounts on stainless steel wall plate with all hardware. Model 2718K51 manufactured by Amtekco.
  - b. Mop Hanger: Three spring-loaded, molded rubber mop holders attached to 3 x 26 inch stainless steel wall plate with all hardware. Model 6582A73 manufactured by Amtekco.

## Q. Water Cooler (P-9)

1. Specified under Section 224700.

## R. Safety Center (P-10) (Barrier Free)

1. Fixture: ANSI Z358.1; combination shower and eyewash unit, 10 inch diameter stainless steel showerhead, 11-1/2 inch diameter stainless steel eye/face wash bowl, two eye/face spray heads with internal flow control and filter to remove impurities from water flow and 1 inch type 316 stainless steel stay-open ball valve. Model GBF1909SSH with FC20 flow control manufactured by Guardian.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

**3.2 PREPARATION**

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

### **3.3 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install each fixture with trap, easily removable for servicing and cleaning.
- C. Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops, reducers, and escutcheons.
- D. Install components level and plumb.
- E. Install and secure fixtures in place with wall supports or wall carriers and bolts.
- F. Seal fixtures to wall and floor surfaces with sealant. Refer to Architectural plans.

### **3.4 INTERFACE WITH OTHER PRODUCTS**

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

### **3.5 ADJUSTING**

- A. Adjust work under provisions of General Conditions.
- B. Adjust stops or valves for intended water flow rate to fixtures without splashing, or noise.

### **3.6 CLEANING**

- A. Clean work under provisions of General Conditions
- B. At completion clean plumbing fixtures and equipment.

### **3.7 PROTECTION OF FINISHED WORK**

- A. Protect finished Work under provisions of General Conditions.
- B. Do not permit use of fixtures.

**END OF SECTION 22 4000**

**SECTION 22 4700****DRINKING FOUNTAINS AND WATER COOLERS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Type PB, pressure with bubbler, Style W, wall-mounting water coolers.
  - 2. Fixture supports.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC 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 fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

**PART 2 - PRODUCTS**

- A. Water Coolers,:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Elkay Manufacturing Co.
  - b. Halsey Taylor.
  - c. Haws Corporation.
  - d. Larco, Inc.
  - e. Oasis Corporation.
  - f. Sunroc Corp.
2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult-mounting height.
  - a. Cabinet: Bilevel with two attached cabinets, all stainless steel vinyl-covered steel with stainless-steel top.
  - b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
  - c. Control: Push bar. (Left side) sensor ( Right side).
  - d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
  - e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
  - f. Drain(s): Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.1.
  - g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
    - 1) Capacity: 8.8 gph (0.0079 L/s) of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
    - 2) Electrical Characteristics: 1/3 hp; 120-V ac; single phase; 60 Hz.
  - h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.
  - i. Model meeting these requirements:
    - 1) Halsey Taylor Model OVL-IISEBP w/SJ8-a remote chiller

#### **FIXTURE SUPPORTS**

- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Josam Co.
  2. MIFAB Manufacturing, Inc.
  3. Smith, Jay R. Mfg. Co.
  4. Tyler Pipe; Wade Div.
  5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
  6. Zurn Plumbing Products Group; Specification Drainage Operation.
- C. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
  1. Type I: Hanger-type carrier with two vertical uprights.
  2. Type II: Bilevel, hanger-type carrier with three vertical uprights.



3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

### **PART 3 - EXECUTION**

#### **3.1 APPLICATIONS**

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
- B. Set freestanding and pedestal drinking fountains on floor.
- C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view.

#### **3.2 INSTALLATION**

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

#### **3.3 CONNECTIONS**

- A. Connect fixtures with water supplies, traps, and risers, and with soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

**3.4 FIELD QUALITY CONTROL**

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
  - 1. Remove and replace malfunctioning units and retest as specified above.
  - 2. Report test results in writing.

**3.5 ADJUSTING**

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

**END OF SECTION 22 4700**

**SECTION 23 0513****COMMON MOTOR REQUIREMENTS FOR HVAC 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 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.

**1.3 COORDINATION**

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

**PART 2 - PRODUCTS****2.1 GENERAL MOTOR REQUIREMENTS**

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

**2.2 MOTOR CHARACTERISTICS**

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

**2.3 POLYPHASE MOTORS**

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F Insert class.
- J. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

**2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS**

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

**2.5 SINGLE-PHASE MOTORS**

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 23 0513**



**SECTION 23 0516****EXPANSION FITTINGS AND LOOPS 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. Pipe loops and swing connections.
  - 2. Alignment guides and anchors.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

**1.4 ALIGNMENT GUIDES AND ANCHORS**

- A. Alignment Guides:
  - 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. Metraflex, Inc.
    - e. U.S. Bellows, Inc.
  - 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
- B. Anchor Materials:
  - 1. Steel Shapes and Plates: ASTM A 36/A 36M.
  - 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
  - 3. Washers: ASTM F 844, steel, plain, flat washers.
  - 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

- a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
- a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
  - c. Washer and Nut: Zinc-coated steel.

## **PART 2 - EXECUTION**

### **2.1 PIPE LOOP AND SWING CONNECTION INSTALLATION**

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

### **2.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION**

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.



1. Anchor Attachment to Steel Structural Members: Attach by welding.
  2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

**END OF SECTION 23 0516**



**SECTION 23 0517****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. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.

**1.3 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.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

**2.2 STACK-SLEEVE FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Smith, Jay R. Mfg. Co.
  - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

**2.3 SLEEVE-SEAL SYSTEMS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
  - 4. Pipeline Seal and Insulator, Inc.
  - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Carbon steel.
  - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

**2.4 SLEEVE-SEAL FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

**2.5 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 (34.5-MPa), 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 (25-mm) annular clear space between piping and concrete slabs and walls.
  - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  - 2. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
  - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) 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 Division 07 Section "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 Division 07 Section "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 (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."

3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
  4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

### **3.3 SLEEVE-SEAL-SYSTEM INSTALLATION**

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

### **3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE**

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Sleeve-seal fittings.
  2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  3. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  4. Concrete Slabs above Grade:

- a. Piping Smaller Than NPS 6 (DN 150): .
  - b. Piping NPS 6 (DN 150) and Larger: Stack-sleeve fittings.
5. Interior Partitions:
- a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
  - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

**END OF SECTION 23 0517**





**SECTION 23 0518****ESCUTCHEONS 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. Escutcheons.
  - 2. Floor plates.

**1.3 SUBMITTALS**

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

**PART 2 - PRODUCTS****2.1 ESCUTCHEONS**

- A. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

**2.2 FLOOR PLATES**

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
  - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
  - b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
  - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
  - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
  - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
  - f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  1. New Piping: 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 23 0518**

**SECTION 23 0519****METERS AND GAGES 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. Liquid-in-glass thermometers.
  - 2. Light-activated thermometers.
  - 3. Thermowells.
  - 4. Dial-type pressure gages.
  - 5. Gage attachments.
  - 6. Test plugs.
  - 7. Test-plug kits.
  - 8. Impeller-turbine, thermal energy measurement system.
- B. Related Sections:
  - 1. Division 23 Section "Facility Natural-Gas Piping" for gas meters.
  - 2. Division 23 Section "Energy Management and Control System" for controls.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product Certificates: For each type of meter and gage, from manufacturer.
- D. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

**PART 2 - PRODUCTS****2.1 LIQUID-IN-GLASS THERMOMETERS**

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Flo Fab Inc.
  - b. Terice, H. O. Co.
  - c. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7 inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
  - a. Design for Air-Duct Installation: With ventilated shroud.
  - b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.2 LIGHT-ACTIVATED THERMOMETERS

### A. Direct-Mounted, Light-Activated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flo Fab Inc.
  - b. Terice, H. O. Co.
  - c. Weiss Instruments, Inc.
2. Case: Metal; 7-inch (178-mm) nominal size unless otherwise indicated.
3. Scale(s): Deg F and deg C.
4. Case Form: Adjustable angle.
5. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
6. Stem: Aluminum and of length to suit installation.
  - a. Design for Air-Duct Installation: With ventilated shroud.
  - b. Design for Thermowell Installation: Bare stem.
7. Display: Digital.
8. Accuracy: Plus or minus 2 deg F (1 deg C).

## 2.3 DUCT-THERMOMETER MOUNTING BRACKETS

- ### A. Description:
- Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

## 2.4 THERMOWELLS

- ### A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ashcroft Inc.
  - b. Flo Fab Inc.
  - c. Marsh Bellofram.
  - d. Terice, H. O. Co.
  - e. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - f. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Sealed type(s); cast aluminum; 4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
12. range.

## 2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

**2.7 TEST PLUGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Peterson Equipment Co., Inc.
  - 2. Trerice, H. O. Co.
  - 3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - 4. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 (DN 8), ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- F. Core Inserts: EPDM self-sealing rubber.

**2.8 TEST-PLUG KITS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. comparable product by one of the following:
  - 1. Peterson Equipment Co., Inc.
  - 2. Trerice, H. O. Co.
  - 3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - 4. Weiss Instruments, Inc.
- C. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
- F. Carrying Case: Metal or plastic, with formed instrument padding.

**2.9 THERMAL ENERGY MEASUREMENT SYSTEM**

- A. Impeller-Turbine, Thermal-Energy Meters:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ONICON Incorporated.
    - b. Data Industrial Corp.

- c. Hoffer Flow Controls, Inc.
  - d. ISTECH Corporation.
2. Description: Basis of Design: ONICON Incorporated System-10-P1 BTU meter with strainer, flow sensor, temperature sensors, transmitter, indicator, thermowells, installation hardware, and connecting wiring.
3. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.
- a. Design: Total thermal-energy measurement. Provide an ONICON Model F-1200 Dual Turbine Flow Meter. The flow meter shall have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST\*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within  $\pm 0.5\%$  of rate at the calibrated velocity, within  $\pm 1\%$  of rate over a 10:1 turndown (3.0 to 30 ft/s) and within  $\pm 2\%$  of rate over a 50:1 turndown (from 0.4 to 20 ft/s). Output signal shall be a 0-15 V square wave pulse.
  - b. Minimum Pressure Rating: 150 psig (1035 kPa).
  - c. Minimum Temperature Range: 40 to 250 deg F (5 to 121 deg C).
  - d. The flow meter shall be installed either in the supply or return pipe of the system to be measured following the manufacturer's instructions with particular attention to upstream and downstream straight pipe runs. Insertion type flow meters shall be provided with all installation hardware necessary to enable insertion and removal of the meter without system shutdown and shall be hand insertable up to 400 psi.
4. Temperature Sensors: Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched (NIST traceable) for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within  $\pm 0.15^\circ\text{F}$  (including the error from individual temperature sensors, sensor matching, input offsets, and calculations).
5. Indicator: Solid-state, integrating-type meter with integral battery pack; for wall mounting.
- a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
  - b. Battery Pack: Five-year lithium battery.
  - c. The BTU meter shall provide the following points both at the integral LCD and as outputs to the building control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. Output signals shall be serial network (protocol conforming to Siemens-P1). Each BTU meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required).
6. Accuracy: Plus or minus 1 percent.
7. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
8. Strainer: Full size of main line piping.
9. Operating Instructions: Include complete instructions with each thermal-energy meter system.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- I. Install test plugs in piping tees.
- J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- K. Install flowmeter elements in accessible positions in piping systems.
- L. Install permanent indicators on walls or brackets in accessible and readable positions.
- M. Install connection fittings in accessible locations for attachment to portable indicators.
- N. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- O. Install thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic boiler.
  - 2. Inlet and outlet of each hydronic coil in air-handling units.
- P. Install pressure gages in the following locations:
  - 1. Discharge of each pressure-reducing valve.
  - 2. Suction and discharge of each pump.

**3.2 CONNECTIONS**

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.



- D. Connect thermal-energy meter transmitters to meters.

### 3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic boiler shall be the following:
  - 1. Direct-mounted, light-activated type.
  - 2. Test plug with EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:
  - 1. Direct-mounted, light-activated type.
  - 2. Test plug with EPDM self-sealing rubber inserts.
- C. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C).

### 3.5 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be the following:
- B. Pressure gages at suction and discharge of each pump shall be the following:
  - 1. Sealed, direct-mounted, plastic case.
  - 2. Test plug with EPDM self-sealing rubber inserts.

### 3.6 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi (0 to 600 kPa).

### 3.7 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine type.

**END OF SECTION 23 0519**



**SECTION 23 0523****GENERAL-DUTY 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. Iron ball valves.
  - 3. Iron, single-flange butterfly valves.
  - 4. Bronze lift check valves.
  - 5. Bronze swing check valves.
  - 6. Iron swing check valves.
  - 7. Chainwheels.
- B. Related Sections:
  - 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
  - 2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

**1.3 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

**1.4 SUBMITTALS**

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

**1.5 QUALITY ASSURANCE**

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Prepare valves for shipping as follows:
  1. Protect internal parts against rust and corrosion.
  2. Protect threads, flange faces, grooves, and weld ends.
  3. Set ball and plug valves open to minimize exposure of functional surfaces.
  4. Set butterfly valves closed or slightly open.
  5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
  1. Maintain valve end protection.
  2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS FOR VALVES**

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  1. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.
  2. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
  1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  1. Flanged: With flanges according to ASME B16.1 for iron valves.
  2. Solder Joint: With sockets according to ASME B16.18.
  3. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

H. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Hammond Valve.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. 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 or TFE.
  - h. Stem: Stainless steel.
  - i. Ball: Stainless steel, vented.
  - j. Port: Full.

## 2.2 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.
  - b. Conbraco Industries, Inc.; Apollo Valves.
  - c. Kitz Corporation.
  - d. Sure Flow Equipment Inc.
  - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - f. NIBCCO, Inc..
2. Description:
  - a. Standard: MSS SP-72.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Split body.
  - d. Body Material: ASTM A 126, gray iron.
  - e. Ends: Flanged.
  - f. Seats: PTFE or TFE.
  - g. Stem: Stainless steel.
  - h. Ball: Stainless steel.
  - i. Port: Full.

## 2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Conbraco Industries, Inc.; Apollo Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. DeZurik Water Controls.
  - e. Hammond Valve.
  - f. Kitz Corporation.
  - g. Milwaukee Valve Company.
  - h. NIBCO INC.
  - i. Red-White Valve Corporation.
  - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
  - a. Standard: MSS SP-67, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
  - e. Seat: EPDM.
  - f. Stem: One- or two-piece stainless steel.
  - g. Disc: Aluminum bronze.

## **2.4 BRONZE LIFT CHECK VALVES**

### **A. Class 125, Lift Check Valves with Bronze Disc:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Nibco, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 1.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Vertical flow.
  - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
  - e. Ends: Threaded.
  - f. Disc: Bronze.

## **2.5 BRONZE SWING CHECK VALVES**

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Valve, Inc.

- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Division.
- e. Hammond Valve.
- f. Kitz Corporation.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Red-White Valve Corporation.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Hammond Valve.
- d. Milwaukee Valve Company.
- e. NIBCO INC.
- f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 4.
- b. CWP Rating: 300 psig (2070 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: PTFE or TFE.

## 2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. NIBCO, Inc.

2. Description:

- a. Standard: MSS SP-71, Type I.

- b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Composition.
- g. Seat Ring: Bronze.
- h. Disc Holder: Bronze.
- i. Disc: PTFE or TFE.
- j. Gasket: Asbestos free.

### **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 chainwheels on operators for butterfly valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
- F. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Lift Check Valves: With stem upright and plumb.



**3.3 ADJUSTING**

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

**3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS**

- A. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball or butterfly valves.
  2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
  3. Pump-Discharge Check Valves:
    - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.
    - b. NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
1. For Copper Tubing, NPS 2 (DN 50) 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 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
  4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
  5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

**3.5 HEATING AND CHILLED WATER VALVE SCHEDULE**

- A. Pipe NPS 2 (DN 50) and Smaller:
1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
  2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
  3. Bronze Swing Check Valves: Class 125, nonmetallic disc.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. 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. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
  3. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM seat, aluminum-bronze disc.
  4. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.

**END OF SECTION 23 0523**



**SECTION 23 0529****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. Hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

- B. Related Sections:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
4. Division 23 Section(s) "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. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses 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 SUBMITTALS**

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

## **1.6 QUALITY ASSURANCE**

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## **PART 2 - PRODUCTS**

### **2.1 METAL PIPE HANGERS AND SUPPORTS**

- A. Carbon-Steel Pipe Hangers and Supports:
  1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
  3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:
  1. Description: MSS SP-58, Types 1, copper-coated-steel, factory-fabricated components.
  2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

### **2.2 TRAPEZE PIPE HANGERS**

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

### **2.3 METAL FRAMING SYSTEMS**

- A. MFMA Manufacturer Metal Framing Systems:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.
    - c. Flex-Strut Inc.
    - d. GS Metals Corp.

- e. Thomas & Betts Corporation.
  - f. Unistrut Corporation; Tyco International, Ltd.
- 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
  - 3. Standard: MFMA-4.
  - 4. Channels: Continuous slotted steel channel with 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 Mechanically-deposited zinc.

## **2.4 THERMAL-HANGER SHIELD INSERTS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Carpenter & Paterson, Inc.
  - 2. Clement Support Services.
  - 3. ERICO International Corporation.
  - 4. National Pipe Hanger Corporation.
  - 5. PHS Industries, Inc.
  - 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, 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 (688-kPa) minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## **2.5 FASTENER SYSTEMS**

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

**2.6 PIPE STANDS**

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
  - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  - 2. Base: Plastic.
  - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. 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.

**2.7 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

**2.8 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 (34.5-MPa), 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. 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 (100 mm) 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 Division 07 Section "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 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 (DN 65) 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 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
  - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
  - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### **3.2 EQUIPMENT SUPPORTS**

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### **3.3 METAL FABRICATIONS**

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.



2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### **3.4 ADJUSTING**

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

### **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 (0.05 mm).
- 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 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 (DN 15 to DN 750).

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
  3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
  5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
  6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
  7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  9. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
  10. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
- 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 (DN 24 to DN 600).
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- 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 (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- 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-joint construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- 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 (32 mm).
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
- 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 powder-actuated fasteners instead of building attachments where required in concrete construction.

**END OF SECTION 23 0529**



**SECTION 230533****HEAT TRACING 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 heat tracing for HVAC piping with the following electric heating cables:
  - 1. Self-regulating, parallel resistance.
- B. Related Requirements:
  - 1. Section 220533 "Heat Tracing for Plumbing Piping."

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include diagrams for power, signal, and control wiring.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

**1.6 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: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS****2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES**

- A. Manufacturers:
1. Thermon
  2. Ray Chem
  3. Chromalox
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, 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: Stainless-steel 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:
- (See Drawings for Electrical Requirements)
1. Maximum Heat Output: 8 W/ft. (26 W/m).

**2.2 CONTROLS**

- A. Remote bulb unit with adjustable temperature range from 30 to 50 deg .
- B. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

**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 230553 "Identification for HVAC Piping and Equipment."
- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
  - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
  - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install electric heating cable across expansion joints according to manufacturer's written instructions; use slack cable to allow movement without damage to cable.
- B. Install electric heating cables after piping has been tested and before insulation is installed.
- C. Install electric heating cables according to IEEE 515.1.
- D. Install insulation over piping with electric cables according to Section 230719 "HVAC Piping Insulation."
- E. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- F. Set field-adjustable switches and circuit-breaker trip ranges.

**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. 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. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- D. Cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.5 PROTECTION**

- A. Protect installed heating cables, including nonheating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

**END OF SECTION**



**SECTION 23 0548****VIBRATION AND SEISMIC CONTROLS 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. This Section includes the following:
  - 1. Isolation pads.
  - 2. Freestanding spring isolators.
  - 3. Spring hangers.
  - 4. Pipe riser resilient supports.
  - 5. Resilient pipe guides.
- B. Related Sections:
  - 1. Division 1, Section 9.0 General Commissioning Requirements+

**1.3 DEFINITIONS**

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Wind-Restraint Loading:
  - 1. Basic Wind Speed: 90 mph. (3 sec)
  - 2. Building Classification Category: IV.
  - 3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: C.
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV
    - a. Component Importance Factor: 1.5.

- b. Component Response Modification Factor: Varies
- c. Component Amplification Factor: Varies
- 3. Design Spectral Response Acceleration at Short Periods : .16
- 4. Design Spectral Response Acceleration at 1-Second Period: 5%

## **1.5 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Welding certificates.

## **1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Refer to Specification Section 019113, General Commissioning Requirements.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Refer to Specification Section 019113, General Commissioning Requirements.
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## **PART 2 - PRODUCTS**

### **2.1 VIBRATION ISOLATORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amber/Booth Company, Inc.
  - 2. Kinetics Noise Control.
  - 3. Mason Industries.
- B. Pads Type 1: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.
- C. Spring Isolators Type 2: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
  6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Spring Hangers Type 2: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- E. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.
- F. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
1. devices to indicate capacity range.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- 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 ADJUSTING**

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust active height of spring isolators.
- C. Adjust restraints to permit free movement of equipment within normal mode of operation.

**3.3 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE**

<b>EQUIPMENT</b>	<b>ISOLATOR TYPE</b>	<b>MIN DEFLECTION (INCHES)</b>
Base Mounted Pumps	Type 1 Pad	.25
In-Line Pumps	Type 2 Hanger	.75
Suspended H & V Units	Type 2 Hanger	.75
In-Line Fans	Type 2 Hanger	.75
Floor Mounted Fans	Type 2	.75
Horizontal Unit Heaters	Type 2 Hanger	.75
Boilers	Type 1	.25

**END OF SECTION 23 0548**

**SECTION 23 0553****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. Pipe labels.
  - 3. Duct labels.
  - 4. Stencils.
  - 5. Valve tags.

**1.3 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.

**1.4 COORDINATION**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

**PART 2 - PRODUCTS****2.1 EQUIPMENT LABELS****A. Metal Labels for Equipment:**

1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

**2.2 PIPE LABELS**

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic 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, pipe size, and an arrow indicating flow direction.
  1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  2. Lettering Size: At least 1-1/2 inches (38 mm) high.

**2.3 DUCT LABELS**

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, 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. Lettering Size: At least 1-1/2 inches (38 mm) high.

## **2.4 DUCT LABELS**

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
  - 1. Stencil Material: Aluminum.
  - 2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

## **2.5 VALVE TAGS**

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
  - 1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

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

### **3.2 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment.

- B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

- A. 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 (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:
1. Heating Water Piping:
    - a. Background Color: White.
    - b. Letter Color: Red.
  2. Refrigerant Piping:
    - a. Background Color: White.
    - b. Letter Color: Black.
  3. Chilled Water Piping
    - a. Background Color: White.
    - b. Letter Color: Blue

### 3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
  2. Yellow: For hot-air supply ducts.
  3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- 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, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.



- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

### **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 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. Hot Water: 1-1/2 inches (38 mm), round.
    - b. Gas: 1-1/2 inches (38 mm), round.
  - 2. Valve-Tag Color:
    - a. Hot Water: Natural.
    - b. Gas: Yellow.
  - 3. Letter Color:
    - a. Hot Water: Black.
    - b. Gas: Black.

**END OF SECTION 23 0553**



**SECTION 23 0593****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 Hydronic Piping Systems:
    - a. Variable-flow hydronic systems.
    - b. Primary-secondary hydronic systems.

**1.3 DEFINITIONS**

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

**1.4 SUBMITTALS**

- A. LEED Submittal:
  - 1. Air-Balance Report for LEED Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- C. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

- D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- E. Certified TAB reports.
- F. Sample report forms.
- G. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

### **1.5 QUALITY ASSURANCE**

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.
- B. TAB Conference: Meet with Architect, Owner, Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
  - 1. Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Coordination and cooperation of trades and subcontractors.
    - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect and Commissioning Authority.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

### **1.6 COORDINATION**

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## **PART 2 - PRODUCTS (Not Applicable)**

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices 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 filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### **3.2 PREPARATION**

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
  - 1. Permanent electrical-power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance, smoke, and fire dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

### **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" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
  - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
  - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, 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. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

**3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS**

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

- a. Report the cleanliness status of filters and the time static pressures are measured.
4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
  1. Measure airflow of submain and branch ducts.
    - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
  3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
  1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
  1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  2. Adjust patterns of adjustable outlets for proper distribution without drafts.

### **3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS**

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.



- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
  2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
  3. Measure total system airflow. Adjust to within indicated airflow.
  4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
  5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
  6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
  7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
  8. Record final fan-performance data.

### **3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS**

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    - a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Division 23 Section "Hydronic Pumps."
  2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
    - a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
  - C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
  - D. Set calibrated balancing valves, if installed, at calculated presettings.
  - E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
    1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
  - F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
  - G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
    1. Determine the balancing station with the highest percentage over indicated flow.
    2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
    3. Record settings and mark balancing devices.
  - H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
  - I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
  - J. Check settings and operation of each safety valve. Record settings.

### **3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS**

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

### **3.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS**

- A. Balance the primary circuit flow first and then balance the secondary circuits.

### **3.10 PROCEDURES FOR MOTORS**

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### **3.11 PROCEDURES FOR CHILLERS**

- A. Balance water flow through the evaporator to within specified tolerances of indicated flow with all pumps operating.
- B. Measure and record the following data with the chiller operating at design conditions:
1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
  2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
  3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
  4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
  5. Capacity: Calculate in tons of cooling.
- C. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving.

### **3.12 PROCEDURES FOR BOILERS**

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

### **3.13 PROCEDURES FOR HEAT-TRANSFER COILS**

- A. Measure, adjust, and record the following data for each water coil:
1. Entering- and leaving-water temperature.
  2. Water flow rate.
  3. Water pressure drop.
  4. Dry-bulb temperature of entering and leaving air.
  5. Wet-bulb temperature of entering and leaving air for cooling coils.
  6. Airflow.
  7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
  2. Airflow.
  3. Entering- and leaving-air temperature at full load.
  4. Voltage and amperage input of each phase at full load and at each incremental stage.

5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

### **3.14 TOLERANCES**

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

### **3.15 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.
- 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 contractor.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. 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. Fan drive settings including settings and percentage of maximum pitch diameter.
    - e. Settings for supply-air, static-pressure controller.
    - f. 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 (mm), and bore.

- i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
  - 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 (mm), and bore.
  - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- 3. Test Data (Indicated and Actual Values):
  - a. Total air flow rate in cfm
  - b. Total system static pressure in inches wg (Pa).
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg (Pa).
  - e. Filter static-pressure differential in inches wg (Pa).
  - f. Preheat-coil static-pressure differential in inches wg (Pa).
  - g. Cooling-coil static-pressure differential in inches wg (Pa).
  - h. Heating-coil static-pressure differential in inches wg (Pa).
  - i. Outdoor airflow in cfm (L/s).
  - j. Return airflow in cfm (L/s).
  - k. Outdoor-air damper position.
  - l. Return-air 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 (mm) o.c.
  - f. Make and model number.
  - g. Face area in sq. ft. (sq. m).
  - h. Tube size in NPS (DN).
  - i. Tube and fin materials.
  - j. Circuiting arrangement.
- 2. Test Data (Indicated and Actual Values):
  - a. Air flow rate in cfm (L/s).
  - b. Average face velocity in fpm (m/s).
  - c. Air pressure drop in inches wg (Pa).
  - d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
  - e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
  - f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
  - g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
  - h. Water flow rate in gpm (L/s).

- i. Water pressure differential in feet of head or psig (kPa).
- j. Entering-water temperature in deg F (deg C).
- k. Leaving-water temperature in deg F (deg C).
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig (kPa).
- n. Refrigerant suction temperature in deg F (deg C).

G. 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 (mm), and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

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 (mm), and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm (L/s).
- b. Total system static pressure in inches wg (Pa).
- c. Fan rpm.
- d. Discharge static pressure in inches wg (Pa).
- e. Suction static pressure in inches wg (Pa).

H. Round, Flat-Oval, 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 (deg C).
- d. Duct static pressure in inches wg (Pa).
- e. Duct size in inches (mm).
- f. Duct area in sq. ft. (sq. m).
- g. Indicated air flow rate in cfm (L/s).
- h. Indicated velocity in fpm (m/s).
- i. Actual air flow rate in cfm (L/s).
- j. Actual average velocity in fpm (m/s).

- k. Barometric pressure in psig (Pa).
- I. Air-Terminal-Device Reports:
  - 1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Apparatus used for test.
    - d. Area served.
    - e. Make.
    - f. Number from system diagram.
    - g. Type and model number.
    - h. Size.
    - i. Effective area in sq. ft. (sq. m).
  - 2. Test Data (Indicated and Actual Values):
    - a. Air flow rate in cfm (L/s).
    - b. Air velocity in fpm (m/s).
    - c. Preliminary air flow rate as needed in cfm (L/s).
    - d. Preliminary velocity as needed in fpm (m/s).
    - e. Final air flow rate in cfm (L/s).
    - f. Final velocity in fpm (m/s).
    - g. Space temperature in deg F (deg C).
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
  - 1. Unit Data:
    - a. System and air-handling-unit identification.
    - b. Location and zone.
    - c. Room or riser served.
    - d. Coil make and size.
    - e. Flowmeter type.
  - 2. Test Data (Indicated and Actual Values):
    - a. Air flow rate in cfm (L/s).
    - b. Entering-water temperature in deg F (deg C).
    - c. Leaving-water temperature in deg F (deg C).
    - d. Water pressure drop in feet of head or psig (kPa).
    - e. Entering-air temperature in deg F (deg C).
    - f. Leaving-air temperature in deg F (deg C).
- K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
  - 1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Service.
    - d. Make and size.
    - e. Model number and serial number.



- f. Water flow rate in gpm (L/s).
- g. Water pressure differential in feet of head or psig (kPa).
- h. Required net positive suction head in feet of head or psig (kPa).
- i. Pump rpm.
- j. Impeller diameter in inches (mm).
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig (kPa).
- b. Pump shutoff pressure in feet of head or psig (kPa).
- c. Actual impeller size in inches (mm).
- d. Full-open flow rate in gpm (L/s).
- e. Full-open pressure in feet of head or psig (kPa).
- f. Final discharge pressure in feet of head or psig (kPa).
- g. Final suction pressure in feet of head or psig (kPa).
- h. Final total pressure in feet of head or psig (kPa).
- i. Final water flow rate in gpm (L/s).
- j. Voltage at each connection.
- k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

### 3.17 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Check the following for each system:
  - a. Measure airflow of at least 10 percent of air outlets.
  - b. Measure water flow of at least 5 percent of terminals.
  - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - d. Verify that balancing devices are marked with final balance position.
  - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect and Commissioning Authority.
  2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect and Commissioning Authority.
  3. Architect 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.
  4. 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."
  5. 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.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. 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 contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

### **3.18 ADDITIONAL TESTS**

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

**END OF SECTION 23 0593**

**SECTION 23 0713****DUCT 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 duct services:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Indoor, concealed return located in unconditioned space.
  - 4. Indoor, exposed return located in unconditioned space.
  - 5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
  - 6. Indoor, concealed oven and warewash exhaust.
  - 7. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  - 8. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
- B. Related Sections:
  - 1. Division 23 Section "HVAC Piping Insulation."

**1.3 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. LEED Submittals:
  - 1. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
  - 2. Laboratory Test Reports for Credit EQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

**1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

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

## **1.6 COORDINATION**

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

## **1.7 SCHEDULING**

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

## **PART 2 - PRODUCTS**

### **2.1 INSULATION MATERIALS**

- A. Comply with requirements in "Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. CertainTeed Corp.; SoftTouch Duct Wrap.
  - b. Johns Manville; Microlite.
  - c. Knauf Insulation; Friendly Feel Duct Wrap.
  - d. Owens Corning; SOFTR All-Service Duct Wrap.
- D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; Commercial Board.
    - b. Johns Manville; 800 Series Spin-Glas.
    - c. Knauf Insulation; Insulation Board.
    - d. Owens Corning; Fiberglas 700 Series.
- E. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; CrimpWrap.
    - b. Johns Manville; MicroFlex.
    - c. Knauf Insulation; Pipe and Tank Insulation.
    - d. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corp.; FlameChek.
    - b. Johns Manville; Firetemp Wrap.
    - c. 3M; Fire Barrier Wrap Products.

## 2.3 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. Products: Subject to compliance with requirements, provide one of the following:
  - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
  - b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## **2.5 TAPES**

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 491 AWF FSK.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - c. Compac Corporation; 110 and 111.
    - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches (75 mm).
  3. Thickness: 6.5 mils (0.16 mm).
  4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

## **2.6 SECUREMENTS**

- A. Insulation Pins and Hangers:
  1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) AGM Industries, Inc.; CWP-1.
      - 2) GEMCO; CD.
      - 3) Midwest Fasteners, Inc.; CD.
      - 4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) AGM Industries, Inc.; CHP-1.
      - 2) GEMCO; Cupped Head Weld Pin.
      - 3) Midwest Fasteners, Inc.; Cupped Head.
      - 4) Nelson Stud Welding; CHP.
  3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      - 2) GEMCO; Peel & Press.
      - 3) Midwest Fasteners, Inc.; Self Stick.
    - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    - c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    - d. Adhesive-backed base with a peel-off protective cover.
  4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) AGM Industries, Inc.; RC-150.
      - 2) GEMCO; R-150.
      - 3) Midwest Fasteners, Inc.; WA-150.
      - 4) Nelson Stud Welding; Speed Clips.
    - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

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

### **3.3 GENERAL INSTALLATION REQUIREMENTS**

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, 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. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  1. Install insulation continuously through hangers and around anchor attachments.
  2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  1. Draw jacket tight and smooth.
  2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.



3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) 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.
- 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 (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### **3.4 PENETRATIONS**

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
  1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
  1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

### 3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins or self sticking base insulation hangers with speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    - b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  2. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
  3. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
  4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins or self sticking base insulation hangers with speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
  - b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
2. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
  - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
3. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
4. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

### **3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION**

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

### **3.7 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.

**3.8 DUCT AND PLENUM INSULATION SCHEDULE, GENERAL****A. Plenums and Ducts Requiring Insulation:**

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed outdoor air.
3. Indoor, exposed cooling supply air.
4. Indoor, concealed return located in unconditioned space.
5. Indoor, exposed return located in unconditioned space.
6. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
7. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
8. Indoor, concealed oven and warewash exhaust.
9. Indoor, exposed oven and warewash exhaust.
10. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
11. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
12. Indoor, concealed vehicle carbon monoxide capture exhaust.
13. Outdoor, concealed supply and return.
14. Outdoor, exposed supply and return.

**B. Items Not Insulated:**

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.
7. Indoor, exposed heating supply air ducts.

**3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE****A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:**

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
3. Mineral-Fiber Board: 1.0-lb/cu ft. thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

**B. Concealed, round and flat-oval duct insulation shall be the following:**

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.0-lb/cu. Ft. nominal density.

**C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:**

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.0 lb/cu. Ft. 3-lb/cu. ft. (48-kg/cu. m) nominal density.

**D. Concealed, rectangular, supply-air duct insulation shall be the following:**

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.0 lb cu. Ft. nominal density.

**E. Concealed, rectangular, outdoor-air duct insulation shall be the following:**

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.0 lb cu. Ft. nominal density.

- F. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.0 lb. cu. Ft. 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- G. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation shall be the following: Fire-rated blanket; thickness as required to achieve 2-hour fire rating.
- H. Concealed, outdoor-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.0 lb/cu. Ft. 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- I. Indoor, concealed vehicle carbon monoxide capture exhaust duct insulation shall be the following:
1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 1.0 lb cu. Ft. nominal density.
- J. Exposed, rectangular, supply-air duct insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- K. Exposed, rectangular, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- L. Exposed, rectangular, exhaust-air duct insulation shall the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- M. Exposed, outdoor-air plenum insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

**END OF SECTION 23 0713**



**SECTION 23 0719****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.
  - 2. Heating hot-water piping.
  - 3. Chilled water pipe insulation.
  - 4. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
  - 1. Division 23 Section "HVAC Equipment Insulation."
  - 2. Division 23 Section "Duct Insulation."

**1.3 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. LEED Submittals:
  - 1. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
  - 2. Laboratory Test Reports for Credit EQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- C. Qualification Data: For qualified Installer.

**1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

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

## **1.6 COORDINATION**

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "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.

## **1.7 SCHEDULING**

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

## **PART 2 - PRODUCTS**

### **2.1 INSULATION MATERIALS**

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.



- D. 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. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Micro-Lok.
    - b. Knauf Insulation; 1000-Degree Pipe Insulation.
    - c. Owens Corning; Fiberglas Pipe Insulation.
  - 2. Type I, 850 deg F (454 deg C) 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. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA, Inc.; Aeroseal.
    - b. Armacell LLC; Armaflex 520 Adhesive.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
  - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic

Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

- 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. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
  - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
  - c. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

- E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Dow Corning Corporation; 739, Dow Silicone.
  - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
  - c. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

## 2.3 MASTICS

- A. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
  - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
  - c. Mon-Eco Industries, Inc.; 55-50.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

**2.4 LAGGING ADHESIVES**

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
  3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
  4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
  5. Color: White.

**2.5 SEALANTS**

- A. Joint Sealants:
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  5. Color: White.
  6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  7. Use sealants that 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," including 2004 Addenda.

**2.6 FACTORY-APPLIED JACKETS**

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
    - a. Products: Subject to compliance with requirements, provide one of the following:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

## **2.7 FIELD-APPLIED JACKETS**

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; Zeston.
    - b. Proto Corporation; LoSmoke.
    - c. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
  4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

## **2.8 TAPES**

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches (75 mm).
  3. Thickness: 11.5 mils (0.29 mm).
  4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

**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. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) 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.

1. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  1. Draw jacket tight and smooth.
  2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm) 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.
- 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 (100 mm) 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. 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 (50 mm) 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.
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 (50 mm).
  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 Division 07 Section "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 Division 07 Section "Penetration Firestopping."

### **3.5 GENERAL PIPE INSULATION INSTALLATION**

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) 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 (150 mm) 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 (25 mm), 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 FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

### 3.9 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

**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. Underground piping.
  - 3. 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 (16 Deg C):
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
    - b. Flexible Elastomeric: 3/4 inch (19 mm) thick.
    - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- B. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and Below:
  - 1. 1-1/2 inch and Smaller: Insulation shall be one of the following:
    - a. Cellular Glass: 1-1/2 inches (38 mm) thick.
    - b. Mineral-Fiber, Preformed Pipe, Type I: 2 inches (50 mm) thick.
  - 2. 2 inch and Larger: Insulation shall be one of the following:
    - a. Cellular Glass: 2 inches (50 mm) thick.
    - b. Mineral-Fiber, Preformed Pipe, Type I or Pipe and Tank Insulation: 2 inches (50 mm) thick.
- C. Chilled Water, above 40 Deg F (5 Deg C):
  - a. Cellular Glass: 2 inches (50 mm) thick.
  - b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) thick.
- D. Refrigerant Suction and Hot-Gas Piping:
  - 1. All Pipe Sizes: Insulation shall be the following: Flexible Elastomeric: 1-1/2 inch (38 mm) thick.
- E. Refrigerant Suction and Hot-Gas Flexible Tubing:
  - 1. All Pipe Sizes: Insulation shall be the following: Flexible Elastomeric: 1-1/2 inch (38 mm) thick.

**3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE**

- A. Chilled Water Supply and Return:

1. All Pipe Sizes: Insulation shall be[ one of] the following:
  - a. Cellular Glass: 3 inches (75 mm) thick.
  - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
- B. Refrigerant Suction and Hot-Gas Piping: All Pipe Sizes: Insulation shall be the following:
- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
  1. All Pipe Sizes: Insulation shall be the following: Flexible Elastomeric: 1-1/2 inch (38 mm) thick.

### **3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  1. None.
- D. Piping, Exposed:
  1. PVC, Color-Coded by System: 20 mils (0.5 mm) thick.

### **3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  1. PVC: 20 mils (0.5 mm) thick.
  2. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
  3. Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- D. Piping, Exposed:
  1. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
  2. Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.

### **3.16 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET**

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

**END OF SECTION 23 0719**

**SECTION 230800****COMMISSIONING OF HVAC****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The purpose of this Section is to specify Division 23 responsibilities in the commissioning process which are being directed by the Commissioning Authority (CxA). Other Mechanical systems testing may be required under the direction of the Construction Manager (CM).
- B. Commissioning requires the participation of Division 23 Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents.
- C. The contractor shall execute all commissioning responsibilities assigned to them described in Section 01 75 00 "General Commissioning Requirements", the Contract Documents, and in the Commissioning Plan issued by the CxA.

**1.2 DEFINITIONS**

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- E. Refer to Section 017500 for additional definitions related to the commissioning process.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.
- C. Pre-functional checklists for all commissioned equipment.
- D. Manufacturer startup forms for all commissioned equipment.
- E. All third party reports and test information require by the Division 23 Sections.

**1.4 RESPONSIBILITIES**

- A. Mechanical Contractor: The commissioning responsibilities applicable to the Division 23 contractor are as follows (all references apply to commissioned equipment):
  - 1. Construction and Acceptance Phases
    - a. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the commissioning process.
    - b. Contractors shall provide product data and shop drawing submittals to the CxA for commissioned equipment during normal submittal procedures.
    - c. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of startup and functional testing procedures
      - 1) Typically this will include detailed manufacturer installation and startup, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, and full factory testing reports, if any, and full

warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA

- 2) The CxA may request further documentation necessary for the commissioning process
  - 3) This data request may be made prior to normal submittals
  - d. Provide a copy of the O&M manual submittals of commissioned equipment, through normal channels, for the CxA for review
  - e. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, drawings or equipment documentation is not sufficient for writing detailed testing procedures.
  - f. Develop a full startup and initial checkout plan using manufacturer's startup procedures and the pre-functional checklists from the CxA. Submit manufacturer's detailed startup procedures and the full startup plan and procedures and other requested equipment documentation to CxA for review.
  - g. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
  - h. Address current A/E punch list items before functional testing.
  - i. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
  - j. Assist the CxA in interpreting the monitoring data, as necessary.
  - k. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC, CM and A/E and retest the equipment.
  - l. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
  - m. During construction, maintain as-built red-line drawings for all drawings and final CAD as-built for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.
  - n. Provide training of the Owner's operating personnel as specified.
  - o. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  - p. Attend testing, adjusting, and balancing review and coordination meeting.
  - q. Participate in orientation and inspection for Division 23 systems, assemblies, equipment, and component maintenance as directed by the CxA.
  - r. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
2. Warranty Period
- a. Execute deferred functional performance testing, witnessed by the CxA, according to the specifications
  - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. TAB Contractor:

1. Provide all TAB reports required by Section 230593 to the CxA for concurrent review with the EOR and Owner.

2. Prerequisite of TAB Verification and Testing: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
3. 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."
4. Scope: HVAC&R air systems and hydronic piping systems.
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.
  - c. Systems operating in full cooling mode.
  - 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

#### **1.5 COMMISSIONING DOCUMENTATION**

- A. Contractor to provide the following information to the CxA for inclusion in the commissioning plan:
  1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
  2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Division 23 systems, assemblies, equipment, and components to be verified and tested.
  4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
  5. Certificate of readiness certifying that Division 23 systems, subsystems, equipment, and associated controls are ready for testing.
  6. Test and inspection reports and certificates.
  7. Corrective action documents.
  8. Verification of testing, adjusting, and balancing reports.

#### **1.6 RELATED WORK**

- A. Refer to Section 017500 for a listing of all sections where commissioning requirements are found.

**PART 2 - PRODUCTS****2.1 TEST EQUIPMENT**

- A. Division 23 shall provide all test equipment necessary to fulfill the testing requirements of this Division.
- B. Refer to Section 017500 for additional Division 23 requirements.

**PART 3 - EXECUTION****3.1 SUBMITTALS**

- A. Division 23 shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 017500 for additional Division 23 requirements

**3.2 STARTUP AND PRE-FUNCTIONAL PROCEDURES**

- A. The Mechanical contractors shall follow the startup and initial checkout procedures listed in the Responsibilities list in this section and in 017500. Division 23 has startup responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the commissioning agent or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and CM. Beginning system testing before full completion does not relieve the Contractor of responsibility for fully completing the system, including all pre-functional checklists as soon as possible.
- C. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- D. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- E. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- F. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- G. Inspect and verify the position of each device and interlock identified on checklists.
- H. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- I. Testing Instrumentation: Provide and install measuring instruments and logging devices to record test data as directed by the CxA.
- J. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.



- K. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work
- L. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
  - 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
  - 2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
  - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
  - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.
- M. The CxA along with the Division 23 Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- N. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
  - 2. Description of equipment for flushing operations.
  - 3. Minimum flushing water velocity.
  - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

### **3.3 FUNCTIONAL PERFORMANCE TESTS**

- A. Refer to Section 3.9 for a list of systems to be commissioned.
- B. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- C. Scope of HVAC&R testing shall include entire HVAC&R installation. Testing shall include measuring capacities and effectiveness of operational and control functions.
- D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and

document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.
- K. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- L. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- M. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- N. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.
- O. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

### **3.4 TESTING DOCUMENTATION, NON-CONFORMANCE, AND APPROVALS**

- A. Refer to Section 017500 for specific details on non-conformance issues relating to pre-functional checklists and tests.
- B. Refer to Section 017500 for issues relating to functional performance tests.

### **3.5 OPERATION AND MAINTENANCE MANUALS (O&M) MANUALS**

- A. Division 23 shall compile and prepare documentation for all equipment and systems covered in Division 23 and deliver to the CM for inclusion in the O&M manuals, according to Sections 013300 and 017700.
- B. The CxA shall receive a copy of the O&M manuals for concurrent review.

### **3.6 TRAINING OF OWNER PERSONNEL**

- A. The CM shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 017500 for additional details.

- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 017500 for additional details.
- C. Provide the CxA with a training plan eight (8) weeks before the planned training according to the outline described in Section 017500.
- D. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned mechanical equipment or system.
- E. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
- F. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- G. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
- H. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
- I. Training shall include:
  - 1. Use the printed installation, operation and maintenance instruction material included in the O&M manuals
  - 2. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
  - 3. Discuss relevant health and safety issues and concerns.
  - 4. Discuss warranties and guarantees.
  - 5. Cover common troubleshooting problems and solutions.
  - 6. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
  - 7. Discuss any peculiarities of equipment installation or operation.
  - 8. The format and training agenda in Guidelines for Commissioning HVAC Systems, ASHRAE, Guideline 0-2005 is recommended.
  - 9. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as appropriate
- J. Hands-on training shall include startup and operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- K. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- L. Training shall occur after functional testing is complete, unless approved otherwise by the CM, Owner, and CxA.

**3.7 DEFERRED TESTING**

- A. Refer to Section 017500 for requirements of deferred testing.

**3.8 WRITTEN WORK PRODUCTS**

- A. Written work products of Contractors will consist of the startup and initial checkout plan described in Section 017500 and the filled out startup, initial checkout and pre-functional checklists.

**3.9 EQUIPMENT AND ASSOCIATED SYSTEMS TO BE COMMISSIONED**

SECTION	SYSTEM DESCRIPTION	SAMPLING
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC	20%
230900	ENERGY MANAGEMENT AND CONTROL SYSTEM	100%
232123	HYDRONIC PUMPS	100%
233423	HVAC POWER VENTILATORS	20%
233500	SLIDING BALANCER TRACK VEHICLE EXHAUST REMOVAL SYSTEM	100%
235216	CONDENSING BOILERS	100%
235523	GAS-FIRED RADIANT HEATERS	100%
238239	SCROLL WATER CHILLERS	100%
237313	MODULAR INDOOR CENTRAL STATION AIR-HANDLING UNITS	100%
237339	OUTDOOR, DIRECT GAS-FIRED HEATING AND VENTILATING UNITS	100%
137414	PACKAGED, CONSTANT VOLUME ROOFTOP AIR HANDLING EQUIPMENT	100%
238126	SPLIT SYSTEM AIR-CONDITIONERS	20%
238239	UNIT HEATERS	20%

**END OF SECTION 230800**

**SECTION 230819****SAMPLE COMMISSIONING CHECKLISTS AND FORMS****PART 1 - GENERAL****1.1 PRE-FUNCTIONAL CHECKLISTS**

- A. The following pages contain representative Pre-Functional Checklists for commissioned equipment which illustrate the level of effort necessary for completion of the checklists.
- B. Similar checklists will be developed by the CxA for all equipment to be commissioned as listed in Division 23 Section "Commissioning of HVAC" and other Divisions to be commissioned, as outlined in Section 017500 "General Commissioning Requirements". Separate checklists will be required for each piece of equipment identified.

**1.2 FUNCTIONAL PERFORMANCE TEST FORMS**

- A. The following pages contain representative Functional Performance Test Forms which illustrates the level of effort and rigor of testing required for completion of the forms.
- B. Similar forms will be developed by the CxA for all equipment to be commissioned as listed in Division 23 Section "Commissioning of HVAC" and other Divisions to be commissioned, as outlined in Section 017500 "General Commissioning Requirements". Separate forms will be required for each piece of equipment identified. Testing sampling is outlined in Sections 017500 and XX0800 of each Division to be commissioned.

**END OF SECTION 230819**

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## Air Handling Unit Pre-Functional Checklist

Project:

Tag:

Project :

Area:

### Documentation

Complete: .

- |                            |   |                            |  |
|----------------------------|---|----------------------------|--|
| <input type="checkbox"/> . | 1. Manufacturer's submittals/shop drawings approved by A/E                    | <input type="checkbox"/> . | 2. Submittals/shop drawings include performance data (fan curves, coil data, etc.) |
| <input type="checkbox"/> . | 3. Submittals/shop drawings include installation and start-up manual and plan | <input type="checkbox"/> . | 4. Submittals/shop drawings include sequences and control strategies               |
| <input type="checkbox"/> . | 5. O&M manuals approved by A/E  | <input type="checkbox"/> . | 6. Factory test results submitted  |
| <input type="checkbox"/> . | 7. Warranty certificate submitted   | <input type="checkbox"/> . | 8. Start-up report completed and provided to commissioning agent                   |

### Model Verification

Complete: .

	Specified	Submitted	Installed
Manufacturer	.	.	.
Model Number	.	.	.
Serial Number	.	.	.
CFM	.	.	.
Cooling Total Capacity MBH	.	.	.
Cooling Sensible Capacity MBH	.	.	.
Heating Capacity MBH	.	.	.
Fan HP	.	.	.
Volts / Phase	.	.	.

### Installation Checks

Complete: .

#### General

- |                            |   |                            |  |
|----------------------------|---|----------------------------|--|
| <input type="checkbox"/> . | 1. Permanent labels affixed, including fans   | <input type="checkbox"/> . | 2. Casing conditions good: no dents, leaks; door gaskets installed   |
| <input type="checkbox"/> . | 3. Access doors close tightly; no leaks   | <input type="checkbox"/> . | 4. Connection between duct and unit tight and in good condition  |
| <input type="checkbox"/> . | 5. Vibration isolation equipment installed and released from shipping locks   | <input type="checkbox"/> . | 6. Maintenance access acceptable for unit and components   |
| <input type="checkbox"/> . | 7. Sound attenuation installed  | <input type="checkbox"/> . | 8. Thermal insulation properly installed and according to specification  |
| <input type="checkbox"/> . | 9. Instrumentation installed according to specification   | <input type="checkbox"/> . | 10. Clean up of equipment completed per contract documents   |
| <input type="checkbox"/> . | 11. If unit starts/runs during construction: maintain quality filters on RA grills, etc. to minimize dirt in ductwork, coils and any finished areas. Verify moisture migration is not a problem due to improper pressures between spaces. | <input type="checkbox"/> . | 12. Verify energy recovery means is installed, in excellent condition, and functional per manufacturer recommendations and contract documents; if applicable |

## ***Air Handling Unit Pre-Functional Checklist***

**Project:**

**Tag:**

**Project :**

**Area:**

<input type="checkbox"/>	13. Clean filters installed and tight fitting; replacement filter type and efficiency permanently affixed to housing. Construction filters removed.	<input type="checkbox"/>	14. Filter pressure differential measuring device installed and functional (magnehelic, inclined manometer, etc.)
<input type="checkbox"/>	15. Startup report completed and copy attached to this checklist.	<input type="checkbox"/>	16. Condensate pump set installation is complete and pumps are operational
<input type="checkbox"/>	17. Condensate pump set has no unusual noise or vibration		
<b>Electrical</b>			
<input type="checkbox"/>	1. Pilot lights functioning	<input type="checkbox"/>	2. Starter overload heaters installed and correct size
<input type="checkbox"/>	3. Safeties installed and safe operating ranges for this equipment provided to the commissioning authority		
<b>Controls</b>			
<input type="checkbox"/>	1. Low limit freeze stat sensor located to deal with stratification and bypass	<input type="checkbox"/>	2. Control system interlocks hooked up and functional
<input type="checkbox"/>	3. All control devices, pneumatic tubing and wiring complete	<input type="checkbox"/>	4. Static pressure or other controlling sensor properly located and per drawings
<input type="checkbox"/>	5. Sensors calibrated (see below)	<input type="checkbox"/>	6. Sensors calibrated (see below)
<input type="checkbox"/>	7. VFD interlocked to control system	<input type="checkbox"/>	8. Smoke detectors in place and wired
<b>Piping</b>			
<input type="checkbox"/>	1. Pipe fittings complete and pipes properly supported	<input type="checkbox"/>	2. Pipes properly labeled
<input type="checkbox"/>	3. Pipes properly insulated	<input type="checkbox"/>	4. Strainers in place and clean
<input type="checkbox"/>	5. Piping system properly flushed	<input type="checkbox"/>	6. No leaking apparent around fittings
<input type="checkbox"/>	7. All coils clean and in good condition	<input type="checkbox"/>	8. All condensate drain pans clean and slope to drain
<input type="checkbox"/>	9. Valves properly labeled	<input type="checkbox"/>	10. Valves installed in proper direction
<input type="checkbox"/>	11. P/T plugs and isolation valves installed per drawings	<input type="checkbox"/>	12. Thermometers and gages installed as specified



## ***Air Handling Unit Pre-Functional Checklist***

**Project:**

**Tag:**

**Project :**

**Area:**

### **Ductwork**

- |   |   |
|---|---|
| <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>1. Sound attenuators installed</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>3. No apparent duct restrictions</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>5. OSA intakes located away from pollutant sources and exhaust outlets</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>7. Control dampers installed per drawings, and operable</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>9. Balancing dampers installed as per drawings and TAB's site visit</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>11. As-built shop drawings submitted</div></div> | <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>2. Duct joint sealant properly installed</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>4. Turning vanes in square elbows as per drawings</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>6. Pressure leakage tests completed</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>8. Ducts cleaned as per specifications</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>10. Ductwork Complete</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>12. Ductwork insulated as specified</div></div> |
|---|---|

### **Fans**

- |  |  |
|--|--|
| <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>1. Supply fan and motor alignment correct (visual)</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>3. Supply fan protective shrouds for belts in place and secure</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>5. Supply fan and motor lube lines installed and lubed</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>7. Return/exhaust fan belt tension and condition good</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>9. Return/exhaust fan area clean</div></div> | <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>2. Supply fan belt tension and condition good</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>4. Supply fan area clean</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>6. Return/exhaust fan and motor aligned</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>8. Return/exhaust fan protective shrouds for belts in place and secure</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>10. Return/exhaust fan and motor lube lines installed and lubed</div></div> |
|--|--|

### **TAB**

- |  |  |
|--|--|
| <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>1. Installation of system and balancing devices allowed access for balancing to be completed effectively per specified NEBB or AABC procedures and contract documents</div></div> | <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>2. TAB report submitted and approved for this equipment</div></div> |
|--|--|

### **Operational Checks**

**Complete:**

.

- |  |  |
|--|--|
| <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>1. All dampers close tightly</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>3. Smoke and fire dampers and unpowered terminal units open</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>5. Return/exhaust fan rotation correct</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>7. Fans &gt; 5 hp phase checks: (% imbalance= 100 x (avg-lowest)/avg). Record all three phases. Imbalance less than 2%?<br/>SAF-____/____/____<br/>RAF/EAF-____/____/____</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>9. Supply fan has no unusual noise or vibration</div></div> | <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>2. All damper linkages have minimum play</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>4. Supply fan rotation correct</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>6. Return/exhaust fan acceptable noise and vibration</div></div> <div style="display: flex; align-items: center;"><div style="border: 1px solid black; width: 40px; height: 20px; margin-right: 10px; text-align: center; line-height: 20px;">.</div><div>8. Record full load running amps for each fan. SAF-____rated FL amps x ____srtc factor=____(max amps). Running less than max? ____ RA/EAF-____rated FL amps x ____srtc factor=____(max amps). Running less than max? ____</div></div> |
|--|--|

## ***Air Handling Unit Pre-Functional Checklist***

**Project:**

**Tag:**

**Project :**

**Area:**

☐ 10. All dampers (OSA, RA, EA, etc) stroke fully without binding and spans calibrated and BAS reading site verified. List dampers checked: OSA-\_\_\_\_RA-\_\_\_\_EA-\_\_\_\_

☐ 12. Valves verified to not be leaking through coils when closed at normal operating pressure

☐ 14. Specified sequences of operation and operating schedules have been implemented with all variations documented

☐ 11. Valves stroke fully and easily. List each actuated valve's checkout: CW-\_\_\_\_HW-\_\_\_\_ER-\_\_\_\_

☐ 13. The HOA switch properly activates and deactivates the unit.

☐ 15. Specified point-to-point checks have been completed and documentation record submitted for this system

**Sensor Actuator Calibration**

**Complete:** ☐

All sensors and gages on this piece of equipment shall be calibrated. All test instruments must have a certificate of calibration dated within the last 12 months

Sensor or Actuator	Location OK	1st BAS Value	1st Instrument	Final BAS Value	Final Instrument	Calibration Correction	Pass Y/N
Sensor							

Gage = Reading of the permanent gage on the equipment. BAS = Building Automation System. Instrument = Testing instrument.

**--- End of Checklist ---**

Functional Performance Test Forms have not been developed for this project specifically. Functional Performance Test Forms will be finalized with equipment submittals are provided and approved.

Sample forms are provided below for the contractor to gauge "level of effort" in functional performance testing.

**SAMPLE Functional Performance Test:**

**FUNCTIONAL PERFORMANCE TEST (FPT-1)  
AIR HANDLING UNIT**

**1. Participants:**

<u>Party</u>	<u>Participation</u>

Party filling out this form & witnessing \_\_\_\_\_ Date of Test: \_\_\_\_\_

**2. Prerequisite Checklist:**

- a. The following have been started up and startup reports and pre-functional checklists submitted and approved ready for functional testing:

\_\_\_\_\_ Chilled/Hot Water System                      \_\_\_\_\_ Associated Air Terminals  
 \_\_\_\_\_ Chilled/Hot water piping and valves                      \_\_\_\_\_ Variable speed drives

- b. \_\_\_\_\_ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final set points and schedules with debugging, loop tuning and sensor calibrations completed.

\_\_\_\_\_  
Controls Contractor Signature

\_\_\_\_\_  
Date

- c. \_\_\_\_\_ Piping system flushing complete and required reports approved.  
 d. \_\_\_\_\_ Water treatment system complete and operational.  
 e. \_\_\_\_\_ Noise and Vibration levels acceptable.  
 f. \_\_\_\_\_ Test, Adjust and Balance (TAB) completed and approved for the hydronic systems and terminal units connected.  
 g. \_\_\_\_\_ All A/E punch list items for this equipment corrected.  
 h. \_\_\_\_\_ These functional test procedures reviewed by installing contractor.  
 i. \_\_\_\_\_ Safeties and operating ranges reviewed.  
 j. \_\_\_\_\_ Test requirements and sequences of operation attached.  
 k. \_\_\_\_\_ Schedules and set points attached.

- l. \_\_\_\_\_ False loading equipment, system and procedures ready (preheat coils, control loops, over-ride on OSA dampers, etc.)
- m. \_\_\_\_\_ Have all energy savings control strategies, set points and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below.
- n. \_\_\_\_\_ Control Program Review. Review the software control program(s) for this equipment. Parameters, set points and logic sequences appear to follow the specified written sequences.
- o. \_\_\_\_\_ Record of "All Values for Current Set points(SP), Control Parameters, Limits, Delays, Lockouts, Schedules, etc., changed to accommodate testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values
Discharge air Static pressure (SP)		
Discharge air Temperature (SP)		
D1 Minimum OA (SP)		
D2 Minimum OA (SP)		
Building Pressure (SP)		

Parameter	Pre-Test Values	Returned to Pre-Test Values
CO2 (SP)		
Low Temp Alarm (SP)		
High Static (SP)		
Mixed air Temperature (SP)		

3. **Sensor Calibration Checks:** Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during pre-functional checklist.

"In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system [BAS]) compared to the test instrument-measured value) is within tolerances specified in the pre-functional checklist requirements. If not, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Sensor & Location	Location OK*	1 <sup>st</sup> Gage or BAS Value	Instr. Meas'd Value	Final Gage or BAS Value	Pass Y/N
DA Temp. TT-2					
RA Temp. TT-3					
RA Humidity MT-3					
OA Temp.					
OA Humidity					
High Static PS-1					
Room Pressure RPS					
MA Temp. TT-1					
DA Static Pressure PT-2					
OA Air Flow CFM					
Preheat Temp. ATS-2					
Cooling Temp. ATS-3					
Humidity Sensor MT-1					
Humidity Sensor MT-2					
Zone CO2 XT-1					

\*Sensor location is appropriate and away from causes of erratic operation.

4. **Device Calibration Checks:** The actuators or devices listed below checked for calibration. This spot check on a sample of the calibrations is conducted during pre-functional check listing and startup.

"In calibration" means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, or a mechanical fix.

Device or Actuator & Location	Procedure or State	BAS Command	Site Observation	Pass Y/N
Cooling coil valve TCV-2 Position Normally closed *	1. Closed			
	2. Full Open			
	3. Fail Safe Operation			
Return Air Damper D-3 Position Normally Open **	1. Closed			
	2. Full Open			
	3. Fail Safe Operation			
OA Damper D1 Position normally closed **	1. Closed			
	2. Full Open			
	3. Minimum Position			
	4. Fail Safe Operation			
OA Damper D2 Position normally closed **	1. Closed			
	2. Full Open			
	3. Minimum Position			
	4. Fail Safe Operation			
SAF VFD Variable frequency IK3 AFD drive speed Output SPD ***	1. Maximum			
	2. Minimum			
SAF Command S/S ***	1. Enable			
	2. Disable			
SAF Status DPS-2 ***	1. On			
	2. Off			
EAF VFD Variable frequency IK4 AFD drive speed Output SPD ****	1. Maximum			
	2. Minimum			
EAF Command S/S ****	1. On			
	2. Off			
EAF Status DPS-1 ****	1. On			
	2. Off			
Heating coil valve TCV-1 Position Normally open *****	1. Closed			
	2. Full Open			
	3. Fail Safe Operation			
Hot Water Circulating Pump Command CSR-1 *****	1. On			
	2. Off			
Hot Water Circulating Pump Status R-1 *****	1. On			
	2. Off			

Device or Actuator & Location	Procedure or State	BAS Command	Site Observation	Pass Y/N
Filter Status *****	1. Normal			
	2. Alarm			
High Discharge Static Alarm *****	1. Normal			
	2. Alarm			
Low Temp Limit *****	1. Normal			
	2. Alarm			
SA Smoke Alarm *****	1. Normal			
	2. Alarm			
RA Smoke Alarm *****	1. Normal			
	2. Alarm			

### Sample Procedures

\* Procedure 1. Lower the discharge set point to 20°F below discharge temperature. Verify BAS reading says Cooling Coil Valve (TCV-2) is 100% open. Visually verify valve is 100% open. Procedure 2. Set discharge set point to 20°F above discharge temperature. Verify BAS reading says Cooling Coil Valve is closed. Procedure 3. Disable the controller and verify that the valve stem and actuator position returns to the normal fail safe position.

\*\* Procedure 1. Command damper closed and verify that damper is shut and BAS reads shut. Procedure 2. Command damper open and verify that damper is open and BAS reads 100% open. Procedure 3. Remove signal from the damper and verify that the actuator position returns to the normal fail safe position.

\*\*\*VFD: Procedure 1. Lower the controlling static pressure set point (duct or discharge) to be ¼ of its current value. Verify that the fan speed is at minimum for VFD *and* packaged controller reads the same. Return the static pressure set point to normal. Procedure 2. Lower the space temperature set point to be 20°F below space temperature and cause TU dampers to go to full cooling. Raise the static pressure set point as necessary (Do not exceed duct design pressure) to cause the set point to not be met (confirm that high static limit sequence functions before attempting this step). Verify that the fan speed is at its maximum and verify that the packaged controller reads the same. Return all components to normal.

\*\*\*\*VFD: Procedure 1. Raise the controlling building pressure set point (Area Served) to be ¼ more of its current value. Verify that the fan speed is at minimum for VFD *and* packaged controller reads the same. Return the building pressure set point to normal. Procedure 2. Lower the controlling building pressure set point (Area Served) to be ¼ of its current value. Verify that the fan speed is at its maximum and verify that the packaged controller reads the same. Return all components to normal.

\*\*\*\*\* Procedure 1. Lower the set point to 20°F below the calculated mixed air heating temperature set point. Verify BAS reading says Preheat Coil Valve is 100% open. Visually verify valve is 100% open. Procedure 2. Set the set point to 20°F above calculated preheat temperature set point. Verify BAS reading says Preheat Coil Valve is closed. Procedure 3. Disable the controller and verify that the valve stem and actuator position returns to the normal fail safe position.

\*\*\*\*\* Procedure 1. Raise (override) the preheat circulation pump outdoor air set point above the sensed outdoor air temperature. Verify the hot water circulating pump indicates on at the BAS. Visually verify pump is running at pump location. Procedure 2. Set (release) preheat circulation pump outdoor air set point back to original setting. Verify the hot water circulating pump indicates off at the BAS. Visually verify pump is off at pump location.

\*\*\*\*\* Procedure 1. Simulate conditions indicated. Return all components to normal.

-----, ---

### 5. Verification of Misc. Pre-functional Checks:

Misc. site checks of the pre-functional checklist and startup reports completed successfully. Pass? Y/N \_\_\_\_\_

#### General Conditions of Test

Verify using trend logs that the control loops are tuned and sequence of operations are followed.

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### 6. Functional Performance Testing Record

Mode	Expected Response	Pass Y/N	Note
Fan Start Up	<b>During supply fan start, verify that:</b>		
	1. Input to the variable frequency drive shall be at a minimum range and perform a ramping sequence on startup to minimize electrical demand and system duct pressure fluctuation		
	2. The supply shall modulate thru the AFD to maintain static pressure set point (1.25" w.c.)		
	3. The economizer exhaust fan shall modulate fan speed proportional to the OA damper position.		
Morning Warm-up	<b>Verify that Optimal start shall be employed and operates as follow:</b>		Verify by trend data.
	1. AHU cooling control valve shall remain closed.		
	2. The supply fan shall be energized.		
	3. The HW control valve modulates to maintain a SA temp. 70°F until the space temperature rises above warm-up mode set point		
Systems Interlock	4. The outside air dampers shall remain fully closed		
	<b>On a call for Cooling or Heating, verify that:</b>		
	1. The appropriate system shall be indexed at the Central Plant.		
	<b>If the unit does not detect hot water or chill water, verify that:</b>		
Demand Control Ventilation (SP=700ppm)	1. The unit will not enter heating, cooling or dehumidification mode of operation.		
	<b>Override the CO<sub>2</sub> set point 200 ppm &lt; the actual indicated CO<sub>2</sub> at the BAS to simulate high concentration of CO<sub>2</sub>, verify that:</b>		
	1. The return damper shall modulate closed to maintain average return CO <sub>2</sub> levels.		OA Damper _____% RA Damper _____
	2. The outside air dampers shall modulate open to maintain average return CO <sub>2</sub> levels.		OA Damper _____% RA Damper _____

Mode	Expected Response	Pass Y/N	Note
Occupied Mode	<b>After morning warm-up/cool-down has occurred verify that:</b>		
	1. The supply fan shall remain energized.		
	2. The outdoor air dampers shall be open to minimum position		OA Damper__% OA Damper__%
	3. The exhaust fan speed shall modulate based on building pressurization. (SP=0.08")		
	<b>Economizer Integration Control- Simulate OAT above(&gt;) 65 F, Verify that:</b>		
	1. The chilled water control valve shall modulate open to maintain the SAT set point.		
	2. The return air damper shall be open		RA Damper__%
	3. The outdoor air dampers shall be at minimum position.		OA Damper__% OA Damper__%
	<b>Economizer Integration Control- Simulate OAT below (&lt;) 65 F, and the OA enthalpy is less (&lt;) than RA enthalpy. Verify that:</b>		
	1. The OA dampers and the RA damper shall modulate to maintain a MAT set point of 55 F.		
	<b>When the OA dampers are fully open and the MAT is above 55 F, Verify that:</b>		
	1. The chilled water control valve shall modulate open to maintain the SAT set point.		
	<b>Override the SAT set point 10°F &gt; 55°F to simulate a fall in temperature, verify that:</b>		
	1. The chilled water control valve shall modulate closed to maintain the SAT set point.		
	<b>MAT Control- Override the SAT set point 5°F &lt; than the actual SAT, verify that:</b>		
	1. The MAT maintains at 55 F		
	2. If OAT is $\leq 40^{\circ}\text{F}$ reset MAT to 65 F. If OAT is $\geq 60^{\circ}\text{F}$ reset MAT to 55 F.		



**SECTION 23 0900****ENERGY MANAGEMENT AND CONTROL SYSTEM****PART 1 - GENERAL****1.1 DESCRIPTION OF WORK**

- A. Provide all labor, materials and devices required for the furnishing, installing and testing of a computer based Energy Management and Automatic Temperature Control System, complete and ready for operation in a manner satisfactory to the Owner. Include all work as indicated on the Drawings, as specified herein and in accordance with the point list.
  - 1. Controls shall be DDC with electric actuators.
- B. Circuits and Junction Boxes have been provided on the electrical drawings for use by the BMS contractor. The BMS contractor is responsible for all power control wiring and transformers beyond this point. The devices include but are not limited to the following.
  - 1. Power for VAV terminals.
  - 2. Power and Fire Alarm interlock wiring for smoke dampers and remote.
  - 3. Power for DDC control panels.
  - 4. Power for all damper actuators.
  - 5. Interlock wiring.
  - 6. Control and interlock wiring for emergency exhaust systems.
  - 7. Power wiring and controls for the emergency exhaust system.
- C. The Energy Management and Automatic Temperature Control System is referred to as the "BMS" for future reference in this specification.

**1.2 REQUIREMENTS OF REGULATORY AGENCIES, STANDARDS, AND RELATED SPECIFICATION SECTIONS**

- A. Regulatory Agencies:
  - 1. International Building Code, 2009 Edition.
  - 2. International Mechanical Code, 2009 Edition.
  - 3. International Plumbing Code, 2009 Edition.
  - 4. The International Energy Conservation Code, 2009 Edition.
- B. Reference Standards:
  - 1. American Society for Testing and Materials (ASTM).
  - 2. Underwriters' Laboratories, Inc. (UL).
  - 3. National Fire Protection Association (NFPA).
  - 4. American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE).
  - 5. National Electrical Code (NEC).

- 6. National Electrical Manufacturers Association (NEMA).
- C. Related Sections:
  - 1. Division 1, Section 960 General Commissioning Requirements+

### **1.3 QUALITY ASSURANCE**

- A. Acceptable Manufacturers: All products, material, and equipment shall be manufactured by Siemens Building Technologies. The BMS system shall be designed and installed, commissioned and serviced by Siemens Building Technologies employed, factory trained personnel. Distributors or licensed installing contractors are not acceptable.
- B. Scope of Work
  - 1. This specification defines the minimum hardware and performance requirements for a computer-based Energy Management and Automatic Temperature Control System.
  - 2. As the BMS Contractor, furnish and install all equipment, accessories, wiring and instrument piping required for a complete and functioning Energy Management System and Automatic Temperature Control System.
  - 3. All materials and equipment used are to be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components are to be thoroughly tested and proven in actual use. All material and equipment are to be installed by the manufacturer. Installing representatives will not be acceptable.

### **1.4 SUBMITTALS**

- A. Manufacturer's literature and illustrations.
- B. Manufacturer's specifications and engineering data.
  - 1. Materials.
  - 2. Parts.
  - 3. Devices.
  - 4. Accessories.
  - 5. Performance Data.
- C. Shop Drawings.
  - 1. Assembly.
  - 2. Installation.
  - 3. Wiring Diagram.

4. Provide electronic format for control documentation (drawings, sequence of operation, and parts list).
- D. At the completion of work, submit report of check-out of the automatic control system.
- E. Provide control diagrams for each system, framed under glass for wall mounting.
- F. Operation and Maintenance Manual:
  1. The manual shall include the following data.
    - a. Installation instructions.
      - 1) Assembly.
      - 2) Installation.
      - 3) Alignment.
      - 4) Adjustment.
      - 5) Checking.
    - b. Operation instructions:
      - 1) Start-up.
      - 2) Routine and normal instructions.
      - 3) Regulation and Control.
      - 4) Shut-down.
    - c. Maintenance instructions.
    - d. Guide to Trouble Shooting.
    - e. Parts List.

## 1.5 WARRANTY

- A. Provide a one (1) year warranty from date of final acceptance by the owner or Certification of substantial completion, whichever occurs later, for items furnished that shall cover.
  1. Faulty or inadequate product design.
  2. Improper assembly or erection.
  3. Defective workmanship and materials.
  4. Leakage, breakage or other failures.

**PART 2 - PRODUCTS****2.1 GENERAL**

- A. The BMS shall incorporate the following:
1. A network of independent, Modular Building and Mechanical Equipment direct digital control units.
  2. A network of independent terminal box Direct Digital Control units.
  3. A trunk interface for communication to the master remote consoles.
  4. Field sensors as indicated and as necessary to accomplish the sequence of operation.
  5. A modem interface for communications to existing remote workstations at the facilities maintenance and operations office (1301 Seven Locks Road, Rockville, Maryland). The BMS network in this project shall be accessible through a dial-in phone line function from any remote workstation utilizing Siemens Building Technologies *Apogee* software. The operation must be able to access, command, and edit all point and program information in the new network from any existing remote workstation.
  6. System Alarm Monitoring
    - a. Critical alarms shall be annunciated at the existing remote workstation in the Maintenance and Operations Office (1301 Seven Locks Road, Rockville, Maryland). Critical alarms shall then be sent from the remote workstation to the Maintenance Personnel Alpha Pagers. Alarms shall have customized text messages with analog value of alarm. Page by this type of alarm - HVAC, maintenance, or life safety. Page to groups or single pages.
- B. Distributed Processing:
1. Each Modular Building Control unit (MBC) or Mechanical Equipment Controller (MEC) shall be capable of performing all specified control functions in a complete independent manner.
  2. "Independent" shall be defined as:
    - a. If any one control unit or communications processor malfunctions within the system, all other control units will continue to control, monitor, have the ability to be accessed and programmed without being in a degraded mode.
- C. Networking:
1. Each MBC/MEC unit shall be capable of sharing point information with other such units, such that control sequences or control loops executed at one control unit may receive input signals from sensors connected to other units within the network without the intervention of the host computer or any hardware other than the modular building controller.

2. If the network communication link fails or the originating control unit malfunctions, the control loop shall continue to function using the last value received from the failed modular building controller or programmed to take special procedures.
  3. Each modular building controller shall have an RS-232 port for use by an ASCII text terminal.
  4. This port shall be capable of communicating with the entire network without moving the operators terminal to other MBC/MEC's or providing any other hardware or software.
  5. Failure of the host shall not affect network and panel to panel communication.
  6. Failure of one modular building controller shall have no other effect upon any of the units in the network.
- D. The BMS Contractor shall provide a Telecommunications Interface Unit (TIU) for support of telecommunications functions.
1. Unit shall allow owner full access to the network from a remote location to control/monitor the entire system.
- E. The BMS Contractor shall provide a power interrupter feature that enables an unattended computer to recover from a commercial power failure.

## **2.2 EXISTING SIEMENS OPERATOR'S TERMINALS (COLOR GRAPHIC/CONTROL):**

- A. Color Graphic Command and Display Operator's Terminal Software:
1. The dynamic color graphic display and command terminal shall be provided which can display alphanumeric data and dynamic color diagrams simultaneously.
    - a. The unit shall display real-time data, generate color schematics of building equipment or areas being monitored, and allow operator commands and report system activity.
    - b. The unit shall support point devices which will allow the operator to make menu selections, execute graphic commands, choose graphic symbols and make freehand drawings.
    - c. The unit shall upon command, generate color schematics of building equipment, or groups of building equipment or areas being monitored, and simultaneously display the current measured variables associated with the equipment or area.
    - d. The color graphic displays shall be dynamic in that point data or calculated values will change continuously while being observed.
    - e. The color terminal shall have a flashing feature to indicate off-normal conditions.
    - f. The color terminal display at least sixteen colors selected from at least 64 combinations.

- g. The CRT shall provide the operator with the ability to command control points from the graphical display, provide change of state message and dynamically update the graphic without the operator requesting the graphic a second time.
- 2. The systems various point lists shall also be dynamic in that they will update change of state or value when displayed on the CRT without re-request by the operator.
- 3. The color terminal shall have an associated keyboard including all standard ASCII characters, a separate numeric keypad and a mouse to position the cursor on the screen.
  - a. In addition, a function keypad shall be provided which shall include a minimum of twelve user-definable keys.
- 4. The color terminal display shall be arranged in a format which allows easy user interaction.
  - a. It shall provide the building operator with the ability to monitor and control his facility through the graphic display screens, without the need for commands or function keys.
  - b. The display format shall be divided into four areas, allocated to specific functions, as follows:
    - 1) Main Menu Area.
    - 2) Main Display Area.
    - 3) Alarm Area.
    - 4) Side Menu Area.
- 5. The Main Menu Area shall always remain on screen, and shall provide menu choices to the operator for ICON function selections.
  - a. It shall be possible for the operator to access and control the system by progressing through various levels shown sequentially in this area.
- 6. The Main Display Area shall display all main screen information resulting from operator request.
  - a. It shall also serve as the display area for user-defined graphics and system reports, and shall be used as a graphic editor workspace.
- 7. The Alarm Area shall always remain on the screen, and shall show, in summary form, the alarm status of the system at all times.
- 8. The Side Menu Area shall appear only when needed.
  - a. It shall be the area where pull-down menus appear for various operator functions.
- 9. Build the following color graphic displays:

- a. Heating Hot Water Systems
- b. Chilled Water System
- c. Each Air Handling System.
- d. Each floor by Building . Each floor shall be the actual CADD Architectural/Mechanical drawing. The BMS contractor shall obtain the CADD floor plans from the Architect/Engineer. Floor plans shall display the following:
  - Room number.
  - Major mechanical, Plumbing, Electrical and Security equipment.
  - Accurately located devices . air terminal units, control devices, etc.
  - Device data and space temperatures.
- e. All points within a system shall be included on at least one (1) graphic.
- f. Provide software links to enable an operator to access an individual equipment/device data starting with an overall facility building plan to individual building plan, floor by floor plan and finally the area/department plan displaying the equipment/device.
- g. Provide software links between floor plans and associated air handling unit and from the air handling unit to the cooling tower, chiller and boiler graphics.
- h. Provide graphic displays showing point logs for terminal boxes. Graphics to display each terminal box space temperature set point and airflow. Temperature set point shall be adjustable from the graphics.
- i. Provide separate Fire Alarm Floor Plan graphics that indicate the location of each fire alarm system device and alarm during alarm mode.

## 2.3 SENSORS

- A. Provide the following instrumentation as required by the monitoring, control and optimization functions.
  1. Temperature sensors.
    - a. Room temperature:
 

Temperature monitoring range	+20/+120 F (0/49 C)
Output signal	Changing resistance
Accuracy at Calibration point	0.5F (+/- 0.3 C)
    - b. Liquid immersion temperature:
 

Temperature monitoring range	+22/+220 F (0/104C)
Output signal	Changing resistance
Accuracy at Calibration point	+/-0.5 F (+/- 0.3 C)
    - c. Duct (single point) temperature:
 

Temperature monitoring range	+40/+150 F (4.4/66 C)
Output signal	Changing resistance
Accuracy at Calibration point	+/-0.5 F (+/- 0.3 C)

- d. Duct (average) temperature:  
Temperature monitoring range +20/+120 F (-7/+49 C)  
Output signal 4 - 20 mA DC  
Accuracy at Calibration point +/-1 F (+/- 0.6 C)  
Sensor Probe Length 25' L (7.3 m)
    - e. Outside air temperature:  
Temperature monitoring range -58/+122 F  
Output signal 4 - 20 mA DC  
Accuracy at Calibration point +/-0.5 F (+/- 0.3 c)
  2. Liquid Differential Pressure Transmitter
 

Ranges	0-5/30 inches H2O 0-25/150 inches H2O 0-125/750 inches H2O
Output	4 - 20 mA DC
Calibration Adjustments	Zero and span
Accuracy	+/-0.2% of span
Linearity	+/-0.1% of span
Hysteresis	+/-0.05% of span
3. Differential pressure:
  - a. Unit for fluid flow proof shall be Penn P74.
 

Range	8 to 70 psi
Differential	3 psi
Maximum differential pressure	200 psi
Maximum pressure	325 psi
  - b. Unit for air flow shall be Siemens Building Technologies SW141.
 

Set point ranges	.05" WG to 1.0" WG 1.0" WG to 12.0" WG
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4. Static Pressure:
  - a. Static pressure sensor:
 

Range	0 to .5" WG ~ to 1" WG ~ to 2" WG ~ to 5" WG ~ to 10" WG
Output Signal	4 - 20 mA VDC
Combined static error	0.5% full range
Operating Temperature	-40 to 175 F.
5. Humidity Sensors
 

Ranges	0 to 99% RH
Sensing Element	Bulk Polymer
Output Signal	4 - 20 mA DC
Accuracy	At 77°F ± 2% RH



## 6. Insertion Flow Meters (Equal to Onicon Series F-1200)

Sensing Method	Impedance Sensing
Accuracy	± 2% of Actual Reading
Maximum Operating Pressure	400 PSI
Output Signal	4 - 20 mA

Bi-directional where required.

## 7. Carbon Monoxide/ Nitrogen Dioxide Sensor/Transmitters

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - (1) Mine Safety Appliances Company (MSA)
  - (2) Sierra Monitor Corporation
  - (3) Vulcain Incorporated
- b. The CO sensor transmitter shall have a full scale detection range of 0-200 part per million (ppm) full scale.
- c. The NO2 sensor transmitter shall have a full scale detection range of 10 part per million (ppm) full scale.
- d. Temperature Range -40deg F to +140 deg F.
- e. The Sensor Transmitter will employ a long-life electro-chemical based technology gas detection element that is precision mounted via sockets directly to the electronics to facilitate calibration and easy replacement.
- f. The Sensor Transmitter shall be constructed of a General Purpose Metal cover Plate to protect against vandalism and accidental damage and installed on a flat surface 4"x 4" metal or PVC enclosure with 3/4" PVC conduit fitting. Natural Gas sensor
- g. Sensor Transmitter shall include an output signal verification jumper that is user selectable to half scale or full scale output to simulate gas detection reading and communication with central control panel without the use of calibration gas.
- h. The Sensor Transmitter shall work by the diffusion principle with no need for external devices to condition or enhance movement of the atmosphere within the area being monitored.
- i. The Sensor Transmitter shall be microprocessor-based capable of digital communication via Siemens P1 Protocol.
- j. Equal to MSA Model Z Gard S for CO and NO2 and MSA model Ultima X for Natural Gas.

**2.4 CONTROL VALVES (All control valves shall have electric actuators).**

## A. Electric Control

Rangeability	40:1
Flow Characteristics	Modify. equal percentage
Control Action	Normal open or Closed as Selected.
Medium	Steam, water, glycol
Body Type	Screwed ends 2" and smaller, flanged valves 2½" and larger
Body Material	Bronze
Body Trim	Bronze
Shut-off Disk on 2-way	Replaceable 2" EPT, 2" Composition
Shut-off Disk on 3-way	Replaceable 2" EPT, 2" Bronze
Stem	Stainless Steel
Actuator	0-10 VDC, 4.20 MA or 2 position 24 VAC/120 VAC

- B. All automatic temperature control valves in water lines shall be provided with characterized throttling plugs and shall be sized for minimum 25% of the system pressure drop or 5 psi, whichever is less.
  - 1. Provide control valves with close off pressure suitable for pressure encountered.
  - 2. Two position valves shall be line size.

## **2.5 DAMPER ACTUATORS**

- A. Electric control shall be Siemens Building Technologies open air direct coupled actuators.
- B. Damper actuators shall be Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.
  - 1. The actuator assembly shall include the necessary hardware and brackets to allow proper mounting and connection to a standard 1/2 inch diameter shaft or damper blade.

## **2.6 MISCELLANEOUS DEVICES**

- A. Thermostats
  - 1. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
  - 2. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
  - 3. Thermostats shall be arranged for either horizontal or vertical mounting.
  - 4. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
  - 5. Mount the thermostat covers with tamper-proof socket head screws.
  - 6. Thermostats shall provide indication of set point and space temperature and shall have local adjustment capability.
- B. Freezestats:
  - 1. Install freezestats as indicated on the plans and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.
    - a. Upon detection of low temperature, the freezestats shall stop the associated supply fans and return the automatic dampers to their normal position. Provide manual reset.
- C. Firestats:
  - 1. Provide manual reset, fixed temperature line voltage type with a bi-metal actuated switch.

- a. Switch shall have adequate rating for required load.

E. Fan Inlet Airflow Measuring Station

1. Each station shall contain parallel air straightener, total and static pressure sensing manifolds, internal piping and external pressure transmission ports with flexible tubing and quick-connect fittings. Fabricate of galvanized steel, size for fan inlet in which mounted. Maximum pressure loss through station of 0.08 inches water gage at 1500 fpm. Station shall have accuracy of 2%. Identify by model number, size, area, and specified airflow capacity.

F. Current Sensing Relay:

1. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
2. Adjust the relay switch point so that the relay responds to motor operation under load as an "on" state and so that the relay responds to an unloaded running motor as an "off" state. A motor with a broken belt is considered an unloaded motor.
3. Provide for status device for all fans and pumps.

G. Automatic Dampers

1. Balanced type with pressed or elliptical steel blades with interlocking edges, mounted horizontally in welded steel frames. Rectangular dampers 12 inches or more in direction perpendicular to axis shall be louvered, with blades not over 8 inches wide. Provide steel trunnions in bronze sleeve bearings or ball bearings. Dampers shall be not more than 48 inches in length between bearings.
2. Dampers shall close with 10 CFM/SF maximum leakage at 4 in. WG differential pressure and provide substantially full area of opening when open. Dampers shall have neoprene edges and end seals cemented and riveted in place during fabrication.
3. Modulating dampers shall be opposed blade type. Two position dampers shall be parallel blade type.
4. Damper blade linkages including operating rods bearings and operator mounting plates shall be designed to withstand twice the required operator force without deflection. Provide for field adjustment of full open position.
5. Acceptable Product: Ruskin CD-35, Penn or Arrow.

## 2.7 TRANSMISSION NETWORK

A. Distributed Communication Processor.

1. The system shall use an intelligent Distributed Communication Processor (DCP).
  - a. It may be a wall-mounted or desk-top unit.

- b. This processor shall be microprocessor based and shall interface the central processing unit and remote units or modular building controllers.
- c. The transmission shall be asynchronous and utilize a token-pass networking method.
- d. The system shall utilize a cyclic redundancy check or dual transmission with parity check to ensure signal reliability.
- e. The network will support up to 100 modular building controllers and additional associated multiple and digital point units.
- f. The transmission network shall utilize a twisted shielded pair.
- g. The transmission speed shall be a minimum of 19.2K baud and operate in a half-duplex mode.

## **2.8 MODULAR BUILDING CONTROLLERS, MECHANICAL EQUIPMENT CONTROLLERS AND ACCESSORIES**

- A. The system shall utilize intelligent distributed Modular Building Controllers (MBC) or Mechanical Equipment Controller (MEC) to interface sensors being monitored and equipment being controlled by the facility management and control system.
  - 1. Each unit shall be microprocessor based and perform the following functions:
    - a. Acquire, process, and transfer information to the central computer, network computer, or other remote units.
    - b. Accept, process, and execute commands from the central computer, network computer, other remote units or other input devices.
    - c. Record, evaluate, and report changes of state and/or value that occur among points associated with the remote unit.
    - d. Locally perform direct digital control (DDC) of all common mechanical system functions, such functions shall be programmed using a sequential, numbered statement programming language (See Software.)
    - e. Support Local Area Network (LAN) trunks.
    - f. Each MBC/MEC shall execute all applicable program--, calculations and commands via a 16-bit microcomputer resident in the unit.
    - g. The microcomputer shall permit floating point calculations to enable the performance of energy calculations.
    - h. Each MBC/MEC shall contain a real-time clock to enable the unit to automatically perform time based functions.
    - i. Each control unit shall be capable of full operation either as a completely independent unit or as a part of the building-wide control system.
      - 1) All units shall contain the necessary equipment for direct interface to the sensors and actuators connected to it.

- 2) Control strategies shall be owner definable at multiple control unit locations, and for all control units in the system from any one operator terminal.
  - j. Each MBC/MEC shall include its one microcomputer direct digital controller, power supply, input/output modules, and battery.
    - 1) The battery shall be self-charging and be capable of supporting all memory within the control unit if the commercial power to the unit is interrupted or lost for a minimum of 60 days. Provide low battery alarm at the operator's station.
  - k. Each unit shall perform continuous diagnostics, and any malfunction shall be annunciated at the operator's console as well as visually indicated at the remote unit.
    - 1) Failure of any unit on the system shall not affect the proper operation of the remaining system components.
  - 1. The system shall be capable of phased start-up.
    - 1) That is, any unit shall be capable of properly communicating with the rest of the system while remaining units are being installed.
  - m. Surge transient protection shall be provided in each unit for the purpose of suppressing inducted voltage transients.
  - n. All units shall be listed by Underwriters Laboratories (UL) against fire and shock hazard as a signal system appliance unit.
  - o. The unit shall also be listed by UL Canada (ULC) and Canadian Standards Association (CSA).
  - p. Units shall have all metal cabinets.
    - 1) Each unit including cabinet, power supply, function cards and termination modules shall be approved by UL.
  - q. Each unit shall have a pin-hinged door and master keyed lock.
    - 1) Remote units shall be capable of proper operation in an ambient environment of 32 degrees F and 10% to 90% RH.
- B. Input/Output Types:
- 1. Each modular building controller shall be capable of accepting multiple point inputs and outputs.
  - 2. These shall be of four types corresponding to industry nomenclature.
  - 3. They are as follows:
    - a. DIGITAL IN for monitoring status, alarms and accumulating pulses.
    - b. DIGITAL OUT for commanding two and three state devices.

- c. ANALOG IN for measuring values.
    - d. ANALOG OUT for positioning set points.
      - 1) Provide individual manual positioning switch and analog gauge for each analog outputs at the DDC cabinet.
  - 4. It shall be possible for each unit to monitor the following type of inputs, without the addition of equipment outside the unit cabinet:
    - a. Analog inputs.
      - 1. 4 - 20 ma.
      - 2. Thermistors.
      - 3. RTD.
    - b. Digital inputs.
      - 1. Dry contact closure.
      - 2. Pulse accumulator.
  - 5. The control unit shall directly control actuators and control devices.
  - 6. Each control unit shall be capable of providing the following control outputs without the addition of equipment outside the remote unit cabinet (all outputs for this project shall be pneumatic):
    - a. Digital outputs (contact closure).
      - 1. Motor starters, sizes 1-4.
    - b. Analog outputs.
      - 1. 4-20 mA.
      - 2. 0 - 10 vDC.
  - 7. Provide manual override switch at the modular building controller for each digital-out and analog-out point. The digital-out switch will be a hand-off-auto and the analog-out switch a hand-auto with a gradual position switch. DDC system will supervise the position of the override switch for the central operator.
- C. Operator Interface:
- 1. The facility management and control system shall permit full operator communication including obtaining information about the performance of his system; allowing the operator to change the system operation; and diagnosing system malfunctions.
- D. User Programmability:

1. All temperature control strategies and energy management routines shall be definable by the operator through an operator's terminal or a portable programming unit.
2. The system shall be provided complete with all equipment and documentation necessary to allow a trained operator to independently perform the functions listed below:
  - a. Start or stop equipment.
  - b. Monitor the status of equipment being controlled.
  - c. Read the set point of a control loop.
  - d. Determine the control strategies that have been defined for a specific piece of equipment.
  - e. Generate displays of control strategies.
  - f. Add/delete control loops to the system.
  - g. Add/delete points to the system.
  - h. Create, modify or delete control strategies.
  - i. Assign sensors and/or actuators to a control strategy.
  - j. Tune control loops through the adjustment of control loop parameters.
  - k. Enable or disable control strategies.
  1. Generate hard copy records of control strategies on a printer.
  - m. Select points to be alarmable and define the alarm state(s).
- E. Self-Diagnostics and Alarm Reporting:
  1. Each modular building controller shall contain self-diagnostics that continuously monitor the proper operation of the unit.
  2. A malfunction of the unit will be reported, and will inform the operator of the nature of the malfunction and the control unit affected.
  3. It shall be possible to annunciate malfunctions as well as other control unit alarms at a selected operator's terminal.

## **2.9 COMPUTER SOFTWARE**

- A. Operator Access:
  1. Operator/system communication:
    - a. The BMS shall have three levels of security passwords.
    - b. The levels shall be used to allow or disallow use of features of the system by password.

- c. The Master Console shall be able to replace and/or change the network passwords and shall maintain additional security on the BMS System.
  - d. All log on and log off attempts shall be reported by the system to the alarm printer in the building and to the color graphic command/control consoles where a record can be printed of successful and unsuccessful attempts.
- B. Point Database:
  - 1. Logical point names, point descriptions and engineering units shall be operator definable on a per point basis.
- C. Time of Day Scheduling:
  - 1. The operator shall be provide a simple means, based an entry through the CRT into the MBC/MEC, a scheduled format to access a comprehensive program to automatically start and stop designated point according to a stored time.
  - 2. The system shall allow 100 commands per point per day.
  - 3. The TOD system will have a preprogrammed override sequence to allow the operator to override the normal time on or off command for special events with few keystrokes.
  - 4. The system will also have holiday and special day schedules for the operator to assign this information.
    - a. When the system sees a special day, holiday or override schedule it will apply that time schedule to the assigned equipment.
- D. User Control Over System Configuration:
  - 1. Data Base Creation and Modification.
    - a. The intent of this specification is to allow the Owner to independently do his own modifications to the system.
  - 2. All changes shall be done utilizing standard procedures and must be capable of being done while the system is on-line and operational.
    - a. To aid an operator, instructive prompting software shall be provided.
  - 3. Operator shall be required to simply answer to "yes" and "no" type questions as well as provide information such as desired engineering units, point descriptors, and so forth.
  - 4. The Owner must have the minimum capability to do the following:
    - a. Add and delete points.
    - b. Modify any point parameter.
    - c. Change, add or delete English language descriptors.



- d. Change, add or delete engineering units.
  - e. Change, add or delete points in start/stop programs, trend logs, and so forth.
  - f. Select analog alarm limits.
  - g. Adjust analog differentials.
  - h. Create custom relationships between points.
- E. Provide network software that automatically notified the host CPU of an changes made to any modular building controller by the portable terminal.
  - 1. Changes made shall be automatically transmitted by the modular building controller to the host CPU database so that the CPU has the changed data, set point, alarm limit and so forth.
- F. BMS Functions:
  - 1. The following BMS software shall be provided as a minimum:
    - a. Historical Trending - The system software shall provide the ability to historically trend operator selectable points.
      - 1) The operator able to assign any system point, analog or binary, real or calculated to a trend group.
        - a) Trend groups shall consist of a single point or multiple point groups.
      - 2) Operator assignments shall be through the operator's terminal, Master or LAN console in simple English language.
        - a) Points-assigned to a trend group shall be by the point's logical name.
      - 3) Trended values shall be historically retained on the system disk of the Master Console, when attached, for future inquiry.
      - 4) Operator able to request trended values to be retrieved from disk and printed out at operator-defined time intervals.
      - 5) Operator able to define time intervals to one minute resolution.
    - b. Point Trending: Provide trending for input and output points. Initially provide one (1) minute trend intervals for all air handling temperature control loops including valve position, the corresponding duct and/or room temperature and relative humidity conditions to assess tuning stability. Once initial stability is acceptable, provide 15 minute trend intervals for the same points to assess general and seasonal control response. For energy assessment, provide point groups of all floor zone temperatures, zone reheat valve positions, zone airflow volumes, zone damper positions, radiant floor pump operation, and radiant floor slab and space temperature. Also provide trend of the zone points

mentioned to assess control stability and to assess long term energy use patterns. In addition to HVAC parameters, trend the following energy use parameters hourly:

- 1) RTU 1 through 4 kW and kWH (via VFD communications)
- 2) ERU-1 and 2 kW and kWH (via VFD communications)
- 3) Building 1 and 6 boiler thermal energy measurement system outputs.
- 4) Site electrical power monitoring indicated on drawings E-501 (note 9) and E-502 (note 16).

c. Power-fail/Automatic System Restart - Power Failures affecting the BMS shall cause the modular building controller to go into an orderly shutdown with no loss of memory under any circumstances.

- 1) Upon resumption of power to the modular building controller, the system shall automatically restart and print-out the occurrence of the power failure.
- 2) The restart program shall automatically restart affected field equipment. Provide staggered start-up of the HVAC system to minimize inrush.
- 3) Restart shall be of static nature (restart of operator pre-assigned equipment) or an appropriate state restart (places the building equipment in the proper operational state as of the time of return to commercial power).
- 4) The nature of the restart program shall be user-definable.

G. Energy Management Control Functions: The following energy management software shall be provided as a minimum for the purpose of optimizing energy consumption while maintaining occupant comfort.

1. Time of Day Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
  - a. It shall be possible to individually command a point or group of points.
  - b. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
  - c. The operator shall be able to define the following information:
    - 1) Time, day.
    - 2) Commands such as on, off, auto, and so forth.
    - 3) Time delays between successive commands.
    - 4) Special days and holidays, with different schedules.

- 5) There shall be provisions for manual overriding of each schedule by an appropriate operator.
2. Start/Stop Time Optimization: The BMS system shall include a software program to perform optimized start-up and shut-down of selected equipment.
  - a. The SSTO program shall start HVAC equipment at the latest possible time that will still allow the equipment to achieve the desired zone conditions by time of occupancy.
  - b. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
  - c. The SSTO program shall operate in both the heating and cooling seasons.
    - 1) It shall be possible to apply the SSTO program to individual fan systems.
    - 2) The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
  - d. The empirical factors shall relate to the dynamic responsiveness of each particular zone, such as heat retention and transfer coefficients.
  - e. The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
  - f. The system operator shall be able to, for each zone under control of the SSTO program, establish and modify the following parameters:
    - 1) Occupancy period.
    - 2) Desired occupancy temperature.
    - 3) Heating/cooling transfer coefficients.
    - 4) Heating/cooling retention coefficients.
    - 5) Primary equipment lag time.
3. Duty Cycle Control: The BMS shall include a Duty Cycle Control Program (DCCP).
  - a. The DCCP shall periodically stop and start loads according to various patterns.
  - b. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
4. Supply Air Reset: The BMS shall include a software program to perform supply air reset (SAR).

- a. The program shall monitor the status of space sensors in all zones and adjust the supply air temperature set point.
5. Economizer Control: The BMS will control the position of the air handler relief, return, and outside air dampers. If the outside air enthalpy falls below changeover set point the BMS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on outside air enthalpy and will be able to override the economizer cycle and return to minimum outside air operation at any time. Economizer operation shall be overridden based on a high level of outside air humidity.
6. Lighting Control: The BMS shall include monitoring, control, and programming for all lighting control panels.

**2.10 EQUIPMENT CONTROLLERS FOR AIR TERMINAL UNITS (VARIABLE AIR VOLUME BOXES, FAN COIL UNITS)**

- A. Provide for control of each Air Terminal Unit.
- B. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators. Terminal equipment controllers utilizing proprietary control signals and actuators shall not be acceptable.
- C. Each controller performing space temperature control shall be provided with a matching room temperature sensor. The sensor may be either RTD or thermistor type providing the following minimum performance requirements are met:

Accuracy: +/- 1°F. (+/- 0.6°C).

Operating Range: 35°F to 115°F. (2°C to 46°C.)

Set Point Adjustment Range: 55°F to 95°F. (2°C to 30°C).

Set Point Modes: Independent Heating, Cooling, Night Setback-Heating, Night Setback-Cooling.

Calibration Adjustments: None Required.

Installation: Up to 100 ft. from controller.

1. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. In lieu of an internal jack, provide a separate terminal jack mounted on a stainless steel wall plate adjacent to the sensor to facilitate direct access to the controller via the terminal.
2. Each room sensor shall also include the following auxiliary devices:
  - Set Point Adjustment Dial.
  - Temperature Indicator with Digital Display.

## Override Switch.

3. The set point adjustment dial shall allow for modification of the temperature by the occupant. Set point adjustment may be locked out, overridden or limited as to time or temperature through software by an authorized operator at the central workstation, DDC Controller, or via the portable operator's terminal. In lieu of an integral adjustment dial, provide a separate dial mounted on a stainless steel wall plate adjacent to the sensor to perform the specified functionality.
  4. The temperature indicator shall be a bi-metal or mercury thermometer and shall be visible without removing the sensor cover. In lieu of integral indication, provide a separate thermometer or digital readout mounted on a stainless steel wall plate adjacent to the sensor for local temperature indication.
  5. An override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant. The override function may be locked out, overridden or limited as to the time through software by an authorized operator at the central workstation, BMS or via the portable operator's terminal. In lieu of an integral switch, provide a separate momentary contact switch mounted on a stainless steel wall plate adjacent to the sensor to perform the specified functionality.
  6. Room sensors shall be provided for wall locations. Provide a return air plenum sensor where indicated.
- D. Each controller shall perform its primary control function independent of other BMS LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the BMS time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via terminals as specified herein. This functionality shall allow for tighter control of space conditions and shall facilitate optimal occupant comfort and energy savings. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.
- E. Provide each terminal equipment controller with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM, or minimum of 72-hour battery backup shall be provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Provide uninterruptible power supplies (UPSS) of sufficient capacities for all terminal controllers that do not meet this protection requirement. operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.
- F. Variable Air Volume Box Controllers: Shall support the following types of pressure independent terminal boxes as a minimum:
1. All Air Terminal Unit control applications shall be field-selectable such that a single controller may be used in conjunction with any of the above types of terminal units to perform the specified sequences of control. This requirement must be met in order to allow for future design and application changes and to

facilitate system expansions. Controllers that require factory application changes are not acceptable.

2. The Air Terminal Unit controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. The BMS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range. The controllers shall also function normally under ambient conditions of 32 degrees to 122 degrees F. (0 degrees to 50 degrees C) and 10% to 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
3. The controller shall include a differential pressure transducer that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual air flow. Single point air velocity sensing is not acceptable. The differential pressure transducer shall have a measurement range of 0 to 400 fpm (0 to 20.4 m/s) and measurement accuracy of +/- 5% at 400 to 400 fpm (2 to 20 m/s), insuring primary air flow conditions shall be controlled and maintained to within +/- 5% of set point at the specified parameters. The BMS contractor shall provide the velocity sensor if required to meet the specified functionality.
4. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 CFM air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.
5. The Air Terminal unit controller shall interface to a matching room temperature sensor as previously specified. The controller shall function to maintain space temperature to within +/- 1.5 degrees F. (.9 degrees C) of set point at the room sensor location.
6. Each controller performing space heating control shall incorporate an algorithm allowing for modulation of a hot water reheat valve or cycling up-the three (3) stages of electric reheat as required to satisfy space heating requirements. Each controller shall also incorporate an algorithm that allows for resetting of the associated air handling unit discharge temperature if required to satisfy space cooling requirements. This algorithm shall function to signal the respective BMS Controller to perform the required discharge temperature reset in order to maintain space temperature cooling set point.

## **2.11 SYSTEM INTEGRATION**

- A. The BMS contractor shall provide all software and hardware to provide monitoring and alarming to the BMS through software gateways for the following systems.
  1. Variable Frequency Drives (VFDs)
    - a. The BMS shall communicate with the VFD through an RS-485 port.

- b. Communication capabilities shall include, but not be limited to, run-stop control, speed set adjustment, proportional/integral controller adjustments, current limits, and accel/decel time adjustments. The drive shall have the capability of allowing the BMS to monitor feedback such as output speed/frequency, current (in amps), % torque, % power, kilowatt hours, relay outputs, and diagnostic fault information.
- c. The VFD shall have direct connectivity to the BMS via a single shielded twisted pair of wire. Through this interface the drive must operate as a LAN device. All required information for operation of the VFD must be communicated through the BMS. The VFD supplier will provide all software and hardware internal to the VFD to accomplish this.

2. Fire Alarm System

The BMS shall directly communicate with the Fire Alarm System. The BMS shall communicate with the fire alarm equipment to provide monitoring of all status changes for the fire alarm devices such as, smoke detectors, pull station, etc. Status conditions would detect normal, trouble, alert, and alarm modes.

3. Boilers

The BMS shall directly communicate with the Boiler Control Panel. The BMS shall communicate with the Boiler and Chiller equipment to provide all control and monitoring functions that are provided within the respective Control Panels.

4. Integration Start-Up and Check-Out Procedure

The BMS supplier shall independently start-up, check-out, and test all software and verify communication between all components. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that all terminations are tight. Verify that all analog and binary input/output points read properly. Verify all alarms and interlocks.

5. Integration Joint Commissioning - Verify Operation of the Integrated System

Upon review of software, a point to point test of the integrated control installation shall commence. The system supplier representative in conjunction with a BMS representative shall test actual field operation of each control and sensing point. Compare the values read in the BMS to those indicated on the system equipment.

When the point to point input/output testing is successfully completed, a series of hardware/software systems test shall be performed. All groups of points that yield system control shall be tested for compliance with the sequence of operation.

## **PART 3 - EXECUTION**

### **3.1 BMS WIRE**

A. General:

- 1. All BMS input/output signal wiring shall be in metal conduit.

2. All low voltage concealed cable may be plenum rated cable installed without conduit.
  3. BMS contractor to provide all power wiring as required by their system.
  4. Route conduits in parallel banks with all changes of direction made at 90 degree angles.
- B. Locate, size and support temperature sensing elements in air streams to properly sense the representative temperature.
1. In the case of controlling transmitting and indicating elements, locate the sensing device, sized and of the type to sense the average conditions.
  2. In the case of safety elements, locate the sensing device and of the type to sense the extreme condition.
  3. Sensing elements in double wall casings and insulated cuts shall have the entire active portion within the air stream.
- C. Install temperature sensing elements in fluid lines and vessels with Type 304 stainless steel or monel wells filled with a non-solidifying heat conducting paste.
1. Locate sensing elements such that they are in the path of moving fluid and not positioned in stagnant or dead end locations.
  2. Wells shall not obstruct the flow of the fluid being measured.
  3. Increase all pipes 1 inch and smaller at least one (1) pipe size at the point of insertion.
- D. Where insulation on piping, ductwork, or equipment is punctured or penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight.
1. Where control devices are to be located on insulated surfaces, provide brackets to clear the finished surface of the insulation voiding punctures of the vapor seal.
- E. Locate, support, enclose, and install control devices and equipment such that they will not be subject to vibration, excessive temperatures, dirt, moisture, or other harmful effects or conditions beyond their rated limitations.
- F. Check and verify location of thermostats and other exposed control sensors with plans and room details before installation.
1. Locate thermostats such that the top of the device is no more than 48 inches above the finished floor.
- G. Interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.
- H. Conceal sensing lines, cables, capillaries, and so forth, in all areas except equipment rooms, and other unfinished spaces.
- I. Route sensing lines, cables, capillaries, and so forth, in all areas except equipment rooms, and other unfinished spaces.



- J. Install control valves horizontal with power unit up unless indicated otherwise.
- K. Install pressure sensing elements in ducts and casings with clean sharp taps to accurately read true static pressure avoiding velocity and turbulence influences.
- L. Control valve and damper operators shall be capable of smoothly positioning under load through the full ranges and strokes indicated in both directions without binding or fluttering and shall be further capable of holding steady in any intermediate or extreme position while the respective systems are functioning at design flows, temperatures, and pressures.
- M. Unless indicated otherwise, control space temperature within plus or minus 1 degree F and space relative humidity within plus or minus 5 percent of their set point.
- N. All exposed tubing shall be hard copper.

### **3.2 COMPLETION OF INSTALLATION**

- A. Provide all necessary relays, switches, boosters, compressed air filters and regulators, gauges, valves, brackets, linkages, control devices, auxiliaries, fasteners, accessories, and connections to result in complete and operable control system shown on the drawings and specified.

### **3.3 CALIBRATION AND ADJUSTMENT**

- A. Calibrate and adjust all control devices, linkages, accessories, and components for stable and accurate operation to meet the design intent of the specifications and drawings and to obtain optimum performance from the equipment controlled.
- B. Perform the final adjustment, calibration, and checking while the respective controlled systems are in full operation.
  - 1. Cause every device to automatically function as intended to insure its proper operation.

### **3.4 INSTRUCTIONS TO OPERATIONS PERSONNEL**

- A. Refer to Specification Section 019113, General Commissioning Requirements.

### **3.5 COMMISSIONING:**

- A. Provide all material and labor required to fulfill the commissioning requirements as described in the Section COMMISSIONING OF HVAC SYSTEMS.

**END OF SECTION 23 0900**



**SECTION 23 0920****VARIABLE FREQUENCY CONTROLLERS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

**1.3 DEFINITIONS**

- A. BAS: Building automation system.
- B. CE: Conformance Europeene (European Compliance).
- C. CPT: Control power transformer.
- D. EMI: Electromagnetic interference.
- E. IGBT: Insulated-gate bipolar transistor.
- F. LAN: Local area network.
- G. LED: Light-emitting diode.
- H. MCP: Motor-circuit protector.
- I. NC: Normally closed.
- J. NO: Normally open.
- K. OCPD: Overcurrent protective device.
- L. PCC: Point of common coupling.
- M. PID: Control action, proportional plus integral plus derivative.
- N. PWM: Pulse-width modulated.
- O. RFI: Radio-frequency interference.
- P. TDD: Total demand (harmonic current) distortion.

- Q. THD(V): Total harmonic voltage demand.
- R. VFC: Variable-frequency motor controller.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.
- B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
  - 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Enclosure types and details.
    - d. Nameplate legends.
    - e. Short-circuit current (withstand) rating of enclosed unit.
    - f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
  - 2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Product Certificates: For each VFC, from manufacturer.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for setting field-adjustable overload relays.
  - 2. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
  - 3. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

#### **1.5 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store in an area with temperature and humidity maintained within the ranges required by the manufacturer.

## **1.7 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
  - 2. Humidity: Less than 95 percent (noncondensing).
  - 3. Altitude: Not exceeding 3300 feet (1005 m).
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

## **1.8 COORDINATION**

- A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
  - 1. Torque, speed, and horsepower requirements of the load.
  - 2. Ratings and characteristics of supply circuit and required control sequence.
  - 3. Ambient and environmental conditions of installation location.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

## **1.9 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS****2.1 MANUFACTURED UNITS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB.
  2. Baldor Electric Company.
  3. Danfoss Inc.; Danfoss Drives Div.
  4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  6. Siemens Energy & Automation, Inc.
  7. Square D; a brand of Schneider Electric.
  8. Toshiba International Corporation.
  9. Yaskawa Electric America, Inc; Drives Division.
- B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- C. Application: variable torque.
- D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
- E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- G. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
  2. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
  3. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
  4. Humidity Rating: Less than 95 percent (noncondensing).
  5. Altitude Rating: Not exceeding 3300 feet (1005 m).
  6. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.3 times the base load current for two seconds.
  7. Speed Regulation: Plus or minus 5 percent.
  8. Output Carrier Frequency: Selectable; 0.5 to 2.5 kHz.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with **three** selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: Door-interlocked disconnect switch with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

## 2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
  - 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
  - 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
  - 1. Output frequency (Hz).
  - 2. Motor speed (rpm).
  - 3. Motor status (running, stop, fault).
  - 4. Motor current (amperes).
  - 5. Motor torque (percent).
  - 6. Fault or alarming status (code).
  - 7. PID feedback signal (percent).
  - 8. DC-link voltage (V dc).
  - 9. Set point frequency (Hz).
  - 10. Motor output voltage (V ac).
- D. Control Signal Interfaces:
- E. BAS Interface: Factory-installed hardware and software to enable the BMS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
  - 1. Network Communications Ports: Ethernet and RS-422/485.
  - 2. Embedded BMS Protocols for Network Communications: Siemens System 600 APOGEE; protocols accessible via the communications ports.

## 2.3 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of VFCs to less than 5 percent and THD(V) to **5** percent.
- B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

## 2.4 BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.



- B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller.
  - 1. Bypass Contactor: Load-break, IEC-rated contactor.
  - 2. Output Isolating Contactor: Non-load-break, IEC-rated contactor.
- D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
  - 1. NORMAL/BYPASS selector switch.
  - 2. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
  - 3. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  - 4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
  - 5. Overload Relays: NEMA ICS 2.
    - a. Solid-State Overload Relays:
      - 1) Switch or dial selectable for motor-running overload protection.
      - 2) Sensors in each phase.
      - 3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - b. External overload reset push button.

## 2.5 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
  - 1. Dry and Clean Indoor Locations: Type 1.

## 2.6 ACCESSORIES

- A. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
  - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

- B. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with intake and exhaust grills and filters; 120-V ac; obtained from integral CPT .
- C. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

## **2.7 SOURCE QUALITY CONTROL**

- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
  - 1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
  - 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Comply with NECA 1.

**3.3 IDENTIFICATION**

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each VFC with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

**3.4 CONTROL WIRING INSTALLATION**

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 16 Section "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
  - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

**3.5 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. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- E. Tests and Inspections:
  - 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
  3. Test continuity of each circuit.
  4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify **Owner** before starting the motor(s).
  5. Test each motor for proper phase rotation.
  6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. VFCs will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### **3.6 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

### **3.7 ADJUSTING**

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.

### **3.8 PROTECTION**

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

**3.9 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

**END OF SECTION 23 0920**



**SECTION 23 1123**  
**NATURAL-GAS PIPING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Pipes, tubes, and fittings.
  2. Piping specialties.
  3. Piping and tubing joining materials.
  4. Valves.
  5. Pressure regulators.

**1.2 PERFORMANCE REQUIREMENTS**

- A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
  2. Service Regulators: 65 psig (450 kPa) minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: More than 0.5 psig (3.45 kPa) but not more than 2 psig (13.8 kPa).

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- 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.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Operation and maintenance data.

**1.4 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.

## **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.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. OmegaFlex, Inc.
    - b. Parker Hannifin Corporation; Parflex Division.
    - c. Titeflex.
    - d. Tru-Flex Metal Hose Corp.
  2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
  3. Coating: PE with flame retardant.
    - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      - 1) Flame-Spread Index: 25 or less.
      - 2) Smoke-Developed Index: 50 or less.
  4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
  5. Striker Plates: Steel, designed to protect tubing from penetrations.
  6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
  7. Operating-Pressure Rating: 5 psig (34.5 kPa).
- C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A).
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
  2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
    - a. Copper fittings with long nuts.
    - b. Metal-to-metal compression seal without gasket.
    - c. Dryseal threads complying with ASME B1.20.3.



**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 (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches ((1830 mm).)

**B. Quick-Disconnect Devices: Comply with ANSI Z21.41.**

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

**C. 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 (DN 50) and smaller.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

**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.****C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.****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 (DN 50) and Smaller: Comply with ASME B16.33.**

1. CWP Rating: 125 psig (862 kPa).
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 (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

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. 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 brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) 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. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

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. 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, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) 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.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

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. 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.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) 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.

F. Bronze Plug Valves: MSS SP-78.

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. Lee Brass Company.
  - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

## 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 (DN 50) and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

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. Actaris.
  - b. American Meter Company.
  - c. Eclipse Combustion, Inc.
  - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
  - e. Invensys.
  - f. Maxitrol Company.
  - g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig (13.8 kPa).

## **2.6 DIELECTRIC UNIONS**

- 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. Capitol Manufacturing Company.
  2. Central Plastics Company.
  3. Hart Industries International, Inc.
  4. McDonald, A. Y. Mfg. Co.
  5. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
  6. Wilkins; Zurn Plumbing Products Group.
- B. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
- C. Combination fitting of copper alloy and ferrous materials.
- D. Insulating materials suitable for natural gas.
- E. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

## **2.7 SLEEVES**

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

## 2.8 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 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. Advance Products & Systems, Inc.
    - b. Calpico Inc.
    - c. Metraflex Company (The).
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
  - 3. Pressure Plates: Carbon steel.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

## PART 3 - EXECUTION

### 3.1 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. 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.
- C. Copper Tubing with Protective Coating:
  - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- D. Install fittings for changes in direction and branch connections.
- E. Exterior-Wall Pipe Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- F. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals

and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.2 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. Locate valves for easy access.
- G. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- 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 (75 mm) 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. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

- P. Connect branch piping from top or side of horizontal piping.
- Q. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment.
- R. Do not use natural-gas piping as grounding electrode.
- S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

### 3.3 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

### 3.4 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. 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.

**3.5 HANGER AND SUPPORT INSTALLATION**

- A. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
  - 2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
  - 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
- B. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/8 (DN 10): Maximum span, 48 inches (1220 mm); minimum rod size, 3/8 inch (10 mm).
  - 2. NPS 1/2 (DN 15): Maximum span, 72 inches (1830 mm); minimum rod size, 3/8 inch (10 mm).
  - 3. NPS 3/4 (DN 20) and Larger: Maximum span, 96 inches (2440 mm); minimum rod size, 3/8 inch (10 mm).

**3.6 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 (1800 mm) 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.

**3.7 LABELING AND IDENTIFYING**

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

**3.8 FIELD QUALITY CONTROL**

- A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.



- C. Prepare test and inspection reports.

### **3.9 OUTDOOR PIPING SCHEDULE**

- A. Aboveground natural-gas piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.
  - 3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
- B. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.

### **3.10 INDOOR PIPING SCHEDULE**

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
  - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
  - 2. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
  - 3. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
  - 2. Steel pipe with wrought-steel fittings and welded joints.

### **3.11 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE**

- A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.
- B. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.
- C. Valves in branch piping for single appliance shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.

**END OF SECTION 23 1123**



**SECTION 23 2113****HYDRONIC 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. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Hot-water heating piping.
  - 2. Chilled water piping.
  - 3. Makeup-water piping.
  - 4. Condensate-drain piping.
  - 5. Air-vent piping.
  - 6. Safety-valve-inlet and -outlet piping.
- B. Related Sections include the following:
  - 1. Division 1, Section 9.0 General Commissioning Requirements+.
  - 2. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
  - 1. Hot-Water Heating Piping: 125 psig (kPa) at 200 deg F (93 deg C).
  - 2. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
  - 3. Condensate-Drain Piping: 150 deg F (66 deg C).
  - 4. Air-Vent Piping: 200 deg F (93 deg C).
  - 5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

**1.4 SUBMITTALS**

- A. Product Data: For each type of the following:
  - 1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

2. Air control devices.
  3. Chemical treatment.
  4. Hydronic specialties.
- B. Shop Drawings: Detail, at 1/4" (1:50) Insert scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Welding certificates.
- D. Qualification Data: For Installer.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
- G. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

## **1.5 EXTRA MATERIALS**

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
- B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

## **PART 2 - PRODUCTS**

### **2.1 COPPER TUBE AND FITTINGS**

- A. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
- B. Type K (A) soft temper in paragraph below is applicable for belowground installations.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.

### **2.2 STEEL PIPE AND FITTINGS**

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.

## **2.3 JOINING MATERIALS**

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

## **2.4 TRANSITION FITTINGS**

- 1. MSS SP-107, CPVC and PVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

## **2.5 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. Capitol Manufacturing Company.
- b. Central Plastics Company.
- c. Hart Industries International, Inc.
- d. Jomar International Ltd.
- e. Matco-Norca, Inc.
- f. McDonald, A. Y. Mfg. Co.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- h. Wilkins; a Zurn company.

2. Description:

- a. Standard: ASSE 1079.
- b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
- c. 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, Inc.
- d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- e. Wilkins; a Zurn company.

2. Description:

- a. Standard: ASSE 1079.
- b. Factory-fabricated, bolted, companion-flange assembly.
- c. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.

2. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: 150 psig (1035 kPa).
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. 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.
  - b. Grinnell Mechanical Products.
  - c. Matco-Norca, Inc.
  - d. Precision Plumbing Products, Inc.
  - e. Victaulic Company.
2. Description:
  - a. Standard: IAPMO PS 66
  - b. Electroplated steel nipple. complying with ASTM F 1545.
  - c. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
  - d. End Connections: Male threaded.
  - e. Lining: Inert and noncorrosive, propylene.

## 2.6 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing Valves:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong Pumps, Inc.
    - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - c. Flow Design Inc.
    - d. Gerand Engineering Co.
    - e. Griswold Controls.
    - f. Taco.
    - g. Tour & Anderson
  2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
  3. Ball: Brass or stainless steel.
  4. Plug: Resin.
  5. Seat: PTFE.
  6. End Connections: Threaded or socket.
  7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  8. Handle Style: Lever, with memory stop to retain set position.
  9. CWP Rating: Minimum 125 psig (860 kPa).
  10. Maximum Operating Temperature: 250 deg F (121 deg C).
- D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong Pumps, Inc.
    - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - c. Flow Design Inc.

- d. Gerand Engineering Co.
    - e. Griswold Controls.
    - f. Taco.
    - g. Tour & Andersson; available through Victaulic Company.
  2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
  3. Ball: Brass or stainless steel.
  4. Stem Seals: EPDM O-rings.
  5. Disc: Glass and carbon-filled PTFE.
  6. Seat: PTFE.
  7. End Connections: Flanged or grooved.
  8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  9. Handle Style: Lever, with memory stop to retain set position.
  10. CWP Rating: Minimum 125 psig (860 kPa).
  11. Maximum Operating Temperature: 250 deg F (121 deg C).
- E. Diaphragm-Operated, Pressure-Reducing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - d. Conbraco Industries, Inc.
    - e. Spence Engineering Company, Inc.
    - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  2. Body: Bronze or brass.
  3. Disc: Glass and carbon-filled PTFE.
  4. Seat: Brass.
  5. Stem Seals: EPDM O-rings.
  6. Diaphragm: EPT.
  7. Low inlet-pressure check valve.
  8. Inlet Strainer: , removable without system shutdown.
  9. Valve Seat and Stem: Noncorrosive.
  10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- F. Diaphragm-Operated Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - d. Conbraco Industries, Inc.
    - e. Spence Engineering Company, Inc.
    - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  2. Body: Bronze or brass.
  3. Disc: Glass and carbon-filled PTFE.
  4. Seat: Brass.
  5. Stem Seals: EPDM O-rings.
  6. Diaphragm: EPT.
  7. Wetted, Internal Work Parts: Brass and rubber.



8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

## 2.7 AIR CONTROL DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amtrol, Inc.
  2. Armstrong Pumps, Inc.
  3. Bell & Gossett Domestic Pump; a division of ITT Industries.
  4. Taco.
- B. Manual Air Vents:
1. Body: Bronze.
  2. Internal Parts: Nonferrous.
  3. Operator: Screwdriver or thumbscrew.
  4. Inlet Connection: NPS 1/2 (DN 15).
  5. Discharge Connection: NPS 1/8 (DN 6).
  6. CWP Rating: 150 psig (1035 kPa).
  7. Maximum Operating Temperature: 225 deg F (107 deg C).
- C. Automatic Air Vents:
1. Body: Bronze or cast iron.
  2. Internal Parts: Nonferrous.
  3. Operator: Noncorrosive metal float.
  4. Inlet Connection: NPS 1/2 (DN 15).
  5. Discharge Connection: NPS 1/4 (DN 8).
  6. CWP Rating: 150 psig (1035 kPa).
  7. Maximum Operating Temperature: 240 deg F (116 deg C).
- D. Bladder-Type Expansion Tanks:
1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
  3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- E. Tangential-Type Air Separators:
1. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.
  2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
  3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.

4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

## **2.8 GLYCOL MAKEUP UNITS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Bell & Gossett Domestic Pump; a division of ITT Industries.
  2. Wessels Company.
- B. Simplex Package Unit:
  1. Furnish and install as shown on the plans and specifications a packaged, automatic glycol solution make up unit model GMU as manufactured by ITT Bell & Gossett or Model GMP as manufactured by Wessels Company. The package shall consist of a base, polyethylene reservoir with removable lid and visible solution level scale in gallons and liters, y-strainer, isolation valve, pump, open drip-proof motor, pump isolation, check and balance valve, expansion tank, discharge pressure gage, motor contactor, pressure control and necessary interconnecting piping. Pump shall start based on falling pressure. Green light shall indicate power supplied to unit. System shall require a 115/1/60 single power connection and a 3/4" NPT system piping connection. GMU shall provide GPM and maintain a fill pressure as scheduled. Unit includes low level cutout, with red indicator light and 110V contact for alarm indication, to stop the pump during low level condition. Contractor shall furnish application specific pressure reducing valve between the GMU and connection to the system piping.

## **2.9 CHEMICAL TREATMENT**

- A. Bypass Chemical Feeder: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.
  1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- B. Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

## **2.10 HYDRONIC PIPING SPECIALTIES**

- 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 NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
  3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  4. CWP Rating: 125 psig (860 kPa).
- B. Spherical, Rubber, Flexible Connectors:
  1. Body: Fiber-reinforced rubber body.
  2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.

3. Performance: Capable of misalignment.
  4. CWP Rating: 150 psig (1035 kPa).
  5. Maximum Operating Temperature: 250 deg F (121 deg C).
- C. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

## **PART 3 - EXECUTION**

### **3.1 PIPING APPLICATIONS**

- A. Hot-water heating and chilled water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
1. Type K (A), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
  2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Hot-water heating and chilled water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
1. Type K (A), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
  2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- C. Makeup-water piping installed aboveground shall be the following:
1. Type K (A), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- D. Condensate-Drain Indoor Piping: Type M (C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints (outdoors only).
- E. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- F. Air-Vent Piping:
1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
  2. Outlet: Type K (A), annealed-temper copper tubing with soldered or flared joints.
- G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

### **3.2 VALVE APPLICATIONS**

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves where shown on the drawings.

- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

### 3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using **[mechanically formed]** tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
- T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

### **3.4 HANGERS AND SUPPORTS**

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
  - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
  - 2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
  - 3. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).

4. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
  5. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (10 mm).
  6. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (10 mm).
  7. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
  8. NPS 6 (DN 150): Maximum span, 17 feet (5.2 m); minimum rod size, 1/2 inch (13 mm).
  9. NPS 8 (DN 200): Maximum span, 19 feet (5.8 m); minimum rod size, 5/8 inch (16 mm).
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
  2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
  3. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
  4. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
  5. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
  6. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
- E. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

### 3.5 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

**3.6 HYDRONIC SPECIALTIES INSTALLATION**

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches (1200 mm) above the floor. Install feeder in minimum NPS 3/4 (DN 20) bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 (DN 20) pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- F. Install expansion tanks on the floor unless shown otherwise on drawings. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

**3.7 TERMINAL EQUIPMENT CONNECTIONS**

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

**3.8 CHEMICAL TREATMENT**

- A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
  - 1. pH: 9.0 to 10.5.
  - 2. "P" Alkalinity: 100 to 500 ppm.
  - 3. Boron: 100 to 200 ppm.
  - 4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
  - 5. Corrosion Inhibitor:
    - a. Sodium Nitrate: 1000 to 1500 ppm.
    - b. Molybdate: 200 to 300 ppm.
    - c. Chromate: 200 to 300 ppm.
    - d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
    - e. Chromate Plus Molybdate: 50 to 100 ppm each.

6. Soluble Copper: Maximum 0.20 ppm.
  7. Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
  8. Total Suspended Solids: Maximum 10 ppm.
  9. Ammonia: Maximum 20 ppm.
  10. Free Caustic Alkalinity: Maximum 20 ppm.
  11. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maximum 1000.
    - b. Total Anaerobic Plate Count: Maximum 100.
    - c. Nitrate Reducers: 100. Sulfate Reducers: Maximum 0 organisms/ml.
    - d. Iron Bacteria: Maximum 0 organisms/ml.
- B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- C. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
- D. Fill systems indicated to have glycol solutions with the following concentrations:
1. Chilled water: Minimum 25 percent propylene glycol.

### 3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
  2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping: Refer to Specification Section 019113, General Commissioning Requirements.
- C. Perform the following before operating the system:
1. Open manual valves fully.
  2. Inspect pumps for proper rotation.
  3. Set makeup pressure-reducing valves for required system pressure.
  4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  5. Set temperature controls so all coils are calling for full flow.
  6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
  7. Verify lubrication of motors and bearings.

**END OF SECTION 23 2113**



**SECTION 23 2123****HYDRONIC PUMPS****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. Close-coupled, in-line centrifugal pumps.
  - 2. Separately coupled, base-mounted, end-suction centrifugal pumps.

**1.3 DEFINITIONS**

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Mechanical Seals: One mechanical seal(s) for each pump.

**PART 2 - PRODUCTS****2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps Inc.
  2. Aurora Pump; Division of Pentair Pump Group.
  3. Crane Pumps & Systems.
  4. Flowserve Corporation.
  5. Grundfos Pumps Corporation.
  6. ITT Corporation; Bell & Gossett.
  7. Mepco, LLC.
  8. PACO Pumps.
  9. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
  10. Peerless Pump Company.
  11. TACO Incorporated.
  12. Thrush Company Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tapings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
  2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
  3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
  5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  6. Pump Bearings: Permanently lubricated ball bearings.
- D. Motor: Single speed and rigidly mounted to pump casing.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- a. Enclosure: Open, dripproof.
  - b. Enclosure Materials: Cast iron.
  - c. Motor Bearings: Permanently lubricated ball bearings.
  - d. Efficiency: Premium efficient.

**2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps Inc.
  2. Aurora Pump; Division of Pentair Pump Group.
  3. Buffalo Pumps, Inc.
  4. Crane Pumps & Systems.
  5. Flowserve Corporation.
  6. ITT Corporation; Bell & Gossett.
  7. PACO Pumps.
  8. Peerless Pump Company.
  9. TACO Incorporated.
  10. Thrush Company Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
  2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
  3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
  5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, secured to mounting frame, with adjustable alignment.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - a. Enclosure: Open, dripproof.
  - b. Enclosure Materials: Cast iron.
  - c. Motor Bearings: Permanently lubricated ball bearings.
  - d. Efficiency: Premium efficient.

## **2.3 PUMP SPECIALTY FITTINGS**

- A. Suction Diffuser:
  1. Angle pattern.
  2. 175-psig (1204-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting.
  3. Bronze startup and bronze or stainless-steel permanent strainers.
  4. Bronze or stainless-steel straightening vanes.
  5. Drain plug.
  6. Factory-fabricated support.
- B. Triple-Duty Valve:
  1. Angle or straight pattern.
  2. 175-psig (1204-kPa) pressure rating, cast-iron body, pump-discharge fitting.
  3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
  4. Brass gage ports with integral check valve and orifice for flow measurement.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PUMP INSTALLATION**

- A. Comply with HI 1.4 and HI 2.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  2. Construct bases to withstand, without damage to equipment, seismic force required by code.
  3. Construct concrete bases 4 inches (100 mm) high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or unless required for seismic-anchor support.
- D. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment base(s) using elastomeric pads. Comply with requirements for equipment bases specified in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
1. Minimum Deflection: 1/4 inch (6 mm).
  2. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
  3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of concrete base.
  4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  6. Install anchor bolts to elevations required for proper attachment to supported equipment.
  7. Install on 4-inch- (100-mm-) high concrete base.
- E. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps.
1. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
  2. Comply with requirements for hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

### **3.3 ALIGNMENT**

- A. Engage a factory-authorized service representative to perform alignment service.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### **3.4 CONNECTIONS**

- A. Comply with requirements for piping specified in Division 23 Section "Steam and Condensate Heating Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install triple-duty valve on discharge side of pumps.
- F. Install suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### **3.5 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.
  - 4. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in the correct direction.
  - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 6. Start motor.
  - 7. Open discharge valve slowly.

**END OF SECTION 23 2123**

**SECTION 23 2300**  
**REFRIGERANT 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. This Section includes refrigerant piping used for air-conditioning applications.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
  - 2. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
  - 1. Solenoid valves.
  - 2. Strainers.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.
- B. Field quality-control test reports.

**1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

**1.7 QUALITY ASSURANCE**

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

**1.8 PRODUCT STORAGE AND HANDLING**

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

**PART 2 - PRODUCTS****2.1 COPPER TUBE AND FITTINGS**

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
  - 1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
  - 2. End Connections:
    - a. NPS 2 (DN 50) and Smaller: With threaded-end connections.
    - b. NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.
  - 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
  - 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
  - 5. Maximum Operating Temperature: 250 deg F (121 deg C).

**2.2 VALVES AND SPECIALTIES**

- A. Service Valves:
  - 1. Body: Forged brass with brass cap including key end to remove core.
  - 2. Core: Removable ball-type check valve with stainless-steel spring.
  - 3. Seat: Polytetrafluoroethylene.
  - 4. End Connections: Copper spring.
  - 5. Working Pressure Rating: 500 psig (3450 kPa).
- B. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.



1. Body and Bonnet: Plated steel.
  2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Threaded.
  5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter..
  6. Working Pressure Rating: 400 psig (2760 kPa).
  7. Maximum Operating Temperature: 240 deg F (116 deg C).
- C. Install flexible connectors at compressors.
- D. All refrigerant circuit access ports located outdoors are to be provided with locking type tamper resistant caps. Coordinate with Section 23 8126.

### 2.3 REFRIGERANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
  2. DuPont Company; Fluorochemicals Div.
  3. Honeywell, Inc.; Genetron Refrigerants.
  4. INEOS Fluor Americas LLC.
  5. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 3-1/2 (DN 90) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

### 3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- B. Except as otherwise indicated, install valves on inlet and outlet side of filter dryers.
- C. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top..
- D. Install filter dryers in liquid line between compressor and thermostatic expansion valve
- E. Consult refrigeration equipment manufacturer to determine the need for a receiver.
- F. Install receivers sized to accommodate pump-down charge.

- G. Install flexible connectors at compressors.
- H. Install locking type tamper proof resistant caps on refrigerant circuit access ports located outdoors. Coordinate with Section 23 8126.

### 3.3 PIPING INSTALLATION

- A. Design refrigerant piping in accordance with variable refrigerant flow manufacturer's recommendations.
- B. 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.
- C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- D. Install piping adjacent to machines to allow service and maintenance.
- E. Install piping free of sags and bends.
- F. Install fittings for changes in direction and branch connections.
- G. Select system components with pressure rating equal to or greater than system operating pressure.
- H. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- I. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install refrigerant piping in protective conduit where installed belowground.
- J. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- K. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- L. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- M. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."
- N. Install sleeves for piping penetrations of walls, ceilings, and floors.
- O. Install sleeve seals for piping penetrations of concrete walls and slabs.

**3.4 PIPE JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

**3.5 HANGERS AND SUPPORTS**

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
  - 1. NPS 1-1/4 (DN 32): Maximum span, 6 feet (1828 mm); minimum rod size, 3/8 inch (9.5 mm).
  - 2. NPS 1-1/2 (DN 40): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).

**3.6 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Comply with ASME B31.5, Chapter VI.
  - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

**3.7 SYSTEM CHARGING**

- A. Charge system using the following procedures:
  - 1. Install core in filter dryers after leak test but before evacuation.
  - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
  - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
  - 4. Charge system with a new filter-dryer core in charging line.

**3.8 ADJUSTING**

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Open shutoff valves in condenser water circuit.
  - 2. Verify that compressor oil level is correct.
  - 3. Open compressor suction and discharge valves.
  - 4. Open refrigerant valves except bypass valves that are used for other purposes.
  - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

**END OF SECTION 23 2300**

**SECTION 23 2500****HVAC WATER TREATMENT****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 HVAC water-treatment systems:
  - 1. Bypass chemical-feed equipment and controls.
  - 2. Chemical treatment test equipment.
  - 3. HVAC water-treatment chemicals.

**1.3 DEFINITIONS**

- A. TDS: Total dissolved solids.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including hot-water heating and glycol cooling, shall have the following water qualities:
  - 1. pH: Maintain a value within 9.0 to 10.5.
  - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
  - 3. Boron: Maintain a value within 100 to 200 ppm.
  - 4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
  - 5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
  - 6. TDS: Maintain a maximum value of 10 ppm.
  - 7. Ammonia: Maintain a maximum value of 20 ppm.
  - 8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
  - 9. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
    - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.

- c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
- d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
- e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

### **1.5 ACTION SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
  - 1. Bypass feeders.
  - 2. Chemical test equipment.

### **1.6 INFORMATIONAL SUBMITTALS**

- A. Field quality-control test reports.
- B. Other Informational Submittals:
  - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
  - 2. Water Analysis: Illustrate water quality available at Project site.

### **1.7 QUALITY ASSURANCE**

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- 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.

### **1.8 MAINTENANCE SERVICE**

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
  - 1. Initial water analysis and HVAC water-treatment recommendations.
  - 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
  - 3. Periodic field service and consultation.
  - 4. Customer report charts and log sheets.
  - 5. Laboratory technical analysis.
  - 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ampion Corp.
  2. Anderson Chemical Co, Inc.
  3. Aqua-Chem, Inc.; Cleaver-Brooks Div.
  4. Barclay Chemical Co.; Water Management, Inc.
  5. Boland Trane Services
  6. GE Betz.
  7. GE Osmonics.
  8. H-O-H Chemicals, Inc.
  9. Metro Group, Inc. (The); Metropolitan Refining Div.
  10. ONDEO Nalco Company.
  11. Watcon, Inc.

**2.2 MANUAL CHEMICAL-FEED EQUIPMENT**

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 2 gal. (7.6 L).
  2. Minimum Working Pressure: 125 psig (860 kPa).

**PART 3 - EXECUTION****3.1 WATER ANALYSIS**

- A. Perform an analysis of supply water to determine quality of water available at Project site.

**3.2 INSTALLATION**

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Refer to Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic restraints.
- C. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and glycol cooling, and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
2. Install water meter in makeup water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

### **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. 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. Inspect field-assembled components and equipment installation, including piping and electrical connections.
  2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
  4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
  8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- D. Remove and replace malfunctioning units and retest as specified above.

### **3.4 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Section 017900 "Demonstration and Training."
- B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

**END OF SECTION 23 2500**



**SECTION 23 3113****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. Double-wall rectangular ducts and fittings.
3. Single-wall round ducts and fittings.
4. Double-wall round ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.

B. Related Sections:

1. Division 1, Section 960 General Commissioning Requirements+
2. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

**1.4 SUBMITTALS**

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

## B. LEED Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
4. Duct-Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-Up."
5. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
6. Laboratory Test Reports for Credit EQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## C. 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.

## D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Apparatus Bay equipment and installed systems, including but not limited to:
  - a. Ventilation system, including ductwork and equipment
  - b. Vehicle exhaust system
  - c. Infrared system
  - d. Hose reels
  - e. Cord reels
  - f. Lighting
4. Structural members to which duct will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Penetrations of smoke barriers and fire-rated construction.
7. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.

- c. Speakers.
- d. Sprinklers.
- e. Access panels.
- f. Perimeter moldings.

E. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

## 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 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. McGill AirFlow LLC.
  - 2. Sheet Metal Connectors, Inc.
  - 3. United Sheet Metal, Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. 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."
- E. 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."
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
  - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  - 3. Coat insulation with antimicrobial coating.
- G. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.
- H. Formed-on Transverse Joints (Flanges): 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."
- I. 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."

### **2.3 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 Incorporated.
    - d. Sheet Metal Connectors, Inc.
    - e. Spiral Manufacturing Co., Inc.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "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 (1524 mm)] 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."
- 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."

## **2.4 DOUBLE-WALL ROUND DUCTS AND FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lindab Inc.
  2. McGill AirFlow LLC.
  3. SEMCO Incorporated.
  4. Sheet Metal Connectors, Inc.
- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. 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."
  2. 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."
  3. 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."
- C. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.

## 2.5 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 (Z275).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. 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.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

## 2.6 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. Aeroflex USA Inc.
  - b. Armaceil LLC.
  - c. Rubatex International, LLC

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. 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- (2.6-mm- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
  2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) 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 (12.7 m/s).
  7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) 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 (12.7 m/s) or where indicated.
  9. 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.

## 2.7 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 (76 mm)
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. 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 (2500 Pa), 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. Silicon-Based Joint Sealer:

1. Composition 100% silicon
2. Water resistant
3. Operational temperature: =80°F to 450°F continuous.
4. Mildew resistance: Mold and mildew resistant.
5. Non Flammable.
6. Sealer shall be equivalent to McGill Uni-Sil HT.



## **2.8 HANGERS AND SUPPORTS**

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- 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.
  - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## **PART 3 - EXECUTION**

### **3.1 DUCT INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts 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 (25 mm), 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 (38 mm).
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- M. Install horizontal vehicle exhaust pitched to drain to hose.

### 3.2 **INSTALLATION OF EXPOSED DUCTWORK**

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 **ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT**

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet (6 m) in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches (38 mm) from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

**3.4 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 (500 Pa) and Lower: Seal Class B.
  - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): 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 (500 Pa) and Lower: Seal Class C.
  - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
  - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
  - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

**3.5 HANGER AND SUPPORT INSTALLATION**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "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 (610 mm) of each elbow and within 48 inches (1200 mm) 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 (5 m).

- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section 05100 Air Duct Accessories.
- B. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for branch, outlet and inlet, and terminal unit connections.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests: Refer to Specification Section 019113, General Commissioning Requirements.
  - 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 2. Test for leaks before applying external insulation.
  - 3. 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.
  - 4. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests: Refer to Specification Section 019113, General Commissioning Requirements.

### 3.8 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 Division 23 Section "Air Duct Accessories" for access panels and doors.
  - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
  - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 **START UP**

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 **DUCT SCHEDULE**

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
  - a. Pressure Class: Positive 2-inch wg (500 Pa).
  - b. Minimum SMACNA Seal Class: B.
2. Ducts Connected to Constant-Volume Air-Handling Units:
  - a. Pressure Class: Positive 2-inch wg (500 Pa).

- b. Minimum SMACNA Seal Class: B.
  - 3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
    - a. Pressure Class: Positive 3-inch wg (750 Pa).
    - b. Minimum SMACNA Seal Class: A.
  - 4. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 2-inch wg (500 Pa).
    - b. Minimum SMACNA Seal Class: B.
- C. Return Ducts:
- 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa) .
    - b. Minimum SMACNA Seal Class: C.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa)
    - b. Minimum SMACNA Seal Class: B.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    - b. Minimum SMACNA Seal Class: B.
- D. Exhaust Ducts:
- 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Negative 2-inch wg (500 Pa).
    - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa) .
    - b. Minimum SMACNA Seal Class: if negative pressure, and A if positive pressure.
  - 3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
    - a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
    - b. Concealed: Carbon-steel sheet.
    - c. Welded seams and joints.
    - d. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
    - f. SMACNA Leakage Class: 3.
  - 4. Ducts Connected to Dishwasher Hoods:
    - a. Type 304, stainless-steel sheet.
    - b. Exposed to View: No. 4 finish.

- c. Concealed: No. 2D finish.
  - d. Welded seams and flanged joints with watertight EPDM gaskets.
  - e. Pressure Class: Positive or negative 2-inch wg (500 Pa) .
  - f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - g. SMACNA Leakage Class: 3.
- 5. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
  - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
- 6. For Underground Exhaust duct, see Section 233116.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa) .
    - b. Minimum SMACNA Seal Class: B.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa) .
    - b. Minimum SMACNA Seal Class: B.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    - b. Minimum SMACNA Seal Class: B.
- F. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel.
  - 2. Stainless-Steel Ducts:
    - a. Exposed to Airstream: Match duct material.
    - b. Not Exposed to Airstream: Match duct material.
- G. Liner:
  - 1. Transfer Ducts: Flexible elastomeric, 1 inch (25 mm) thick.
- H. Double-Wall Duct Interstitial Insulation:
  - 1. Supply Air Ducts: 1 inch (25 mm) thick.
  - 2. Return Air Ducts: 1 inch (25 mm) thick.
- I. 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 (5 m/s) 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 (5 to 7.6 m/s):
- 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 (7.6 m/s) 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) Retain first three subparagraphs below, or delete and retain fourth subparagraph.
    - 2) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 3) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 4) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    - 5) Radius-to Diameter Ratio: 1.5.
  - b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter:
- J. 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 (5 m/s) or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
  - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

**END OF SECTION 23 3113**



**SECTION 23 3300****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. Control dampers.
  - 3. Fire dampers.
  - 4. Smoke dampers.
  - 5. Flange connectors.
  - 6. Turning vanes.
  - 7. Duct-mounted access doors.
  - 8. Flexible connectors.
  - 9. Flexible ducts.
  - 10. Duct accessory hardware.
- B. Related Sections:
  - 1. Division 1, Section 9 General Commissioning Requirements.
  - 2. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
  - 3. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
  - 2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."
- C. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

**1.4 QUALITY ASSURANCE**

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

**1.5 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

**PART 2 - PRODUCTS****2.1 MATERIALS**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90 (Z275).
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

**2.2 MANUAL VOLUME DAMPERS**

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Air Balance Inc.; a division of Mestek, Inc.
    - b. American Warming and Ventilating; a division of Mestek, Inc.

- c. McGill AirFlow LLC.
  - d. METALAIRE, Inc.
  - e. Nailor Industries Inc.
  - f. Ruskin Company.
  - g. Trox USA Inc.
- 2. Standard leakage rating, with linkage outside airstream.
- 3. Suitable for horizontal or vertical applications.
- 4. Frames:
  - a. Hat-shaped, galvanized-steel channels, 0.064-inch (1.62-mm) minimum thickness.
  - b. Mitered and welded corners.
  - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
- 5. Blades:
  - a. Multiple or single blade.
  - b. Opposed-blade design for multi-blade dampers.
  - c. Stiffen damper blades for stability.
  - d. Galvanized-steel, 0.064 inch (1.62 mm) thick.
- 6. Blade Axles: Galvanized steel Nonferrous metal.
- 7. Bearings:
  - a. Molded synthetic.
  - b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) 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.

## **2.3 CONTROL DAMPERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Warming and Ventilating; a division of Mestek, Inc.
  - 2. Flexmaster U.S.A., Inc.
  - 3. Greenheck Fan Corporation.
  - 4. McGill AirFlow LLC.
  - 5. METALAIRE, Inc.
  - 6. Nailor Industries Inc.
  - 7. Ruskin Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
  - 1. U shaped.
  - 2. Galvanized-steel channels, 0.064 inch (1.62 mm) thick.
  - 3. Mitered and welded corners.
- D. Blades:

1. Multiple blade with maximum blade width of 8 inches (200 mm).
  2. Opposed-blade design.
  3. Galvanized steel.
  4. 0.064 inch (1.62 mm) thick.
  5. Blade Edging: Closed-cell neoprene edging.
- E. Blade Axles: 1/2-inch- (13-mm-) diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
- F. Bearings:
1. Oil-impregnated bronze.
  2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  3. Thrust bearings at each end of every blade.

## 2.4 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
  2. McGill AirFlow LLC.
  3. METALAIRE, Inc.
  4. Nailor Industries Inc.
  5. Prefco; Perfect Air Control, Inc.
  6. Ruskin Company.
  7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.052 or 0.138 inch (1.3 or 3.5 mm) thick, as indicated, and of length to suit application.
  2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

## 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. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: Integral, factory wired for single-point connection.
- D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
- E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
- F. Leakage: Class II.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) 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 Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control 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 (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
  - 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 (minus 40 deg C).
  - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
  - 7. Electrical Connection: 115 V, single phase, 60 Hz.

**2.6 FLANGE CONNECTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Nexus PDQ; Division of Shilco Holdings Inc.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

**2.7 TURNING VANES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. METALAIRE, Inc.
  - 3. SEMCO Incorporated.
  - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
  - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. 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."
- D. Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

**2.8 DUCT-MOUNTED ACCESS DOORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Greenheck Fan Corporation.
  - 3. McGill AirFlow LLC.
  - 4. Nailor Industries Inc.
  - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "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-inch (25-by-25-mm) butt or piano hinge and cam latches.
  - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
  - a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
  - b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
  - c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches.
  - d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

## 2.9 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Ductmate Industries, Inc.
  2. Ventfabrics, Inc.
  3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip [3-1/2 inches (89 mm)] [5-3/4 inches (146 mm)] wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
  2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
  3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
  2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
  3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

**2.10 FLEXIBLE DUCTS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flexmaster U.S.A., Inc.
  2. McGill AirFlow LLC.
  3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Noninsulated, Flexible Duct: UL 181, Class 1, black C.P.E. Fabric Mechanical with no adhesive.
1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
- C. Noninsulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
- D. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
  2. Maximum Air Velocity: 4000 fpm (20 m/s).
  3. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
  4. Insulation R-value: Comply with ASHRAE/IESNA 90.1 R-6 Min. 4q6qMax.
- E. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

**2.11 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 control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. 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.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Upstream from duct filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 5. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 6. At each change in direction and at maximum 50-foot (15-m) spacing.
  - 7. Control devices requiring inspection.
  - 8. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
  - 2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
  - 3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
  - 4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).

- 5. Body Access: 25 by 14 inches (635 by 355 mm).
- 6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).
- K. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. Connect terminal units to supply ducts with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.
- N. Connect diffusers or light troffer boots to ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. 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 (6-mm) movement during start and stop of fans.

### **3.2 FIELD QUALITY CONTROL**

- A. Tests and Inspections: Refer to Specification Section 019113, General Commissioning Requirements

**END OF SECTION 23 3300**

**SECTION 23 3423****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. Ceiling-mounted ventilators.
  - 2. In-line centrifugal fans.
  - 3. Propeller fans.
- B. Related Sections:
  - 1. Division 1, Section 960 General Commissioning Requirements+

**1.3 PERFORMANCE REQUIREMENTS**

- A. Operating Limits: Classify according to AMCA 99.

**1.4 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.
- B. Field quality-control reports.
- C. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

**1.5 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, 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. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

**1.6 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.

**1.7 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Belts: One set(s) for each belt-driven unit.

**PART 2 - PRODUCTS****2.1 CEILING-MOUNTED VENTILATORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Carnes Company.
  - 2. Greenheck Fan Corporation.
  - 3. JencoFan.
  - 4. Loren Cook Company.
  - 5. PennBarry.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Steel Egg crate design with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Motion Sensor: Motion detector with adjustable shutoff timer.
3. Isolation: Rubber-in-shear vibration isolators.
4. Manufacturer's standard roof jack or wall cap, and transition fittings.

## **2.2 IN-LINE CENTRIFUGAL FANS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Manufacturing Corporation.
  2. Carnes Company.
  3. Greenheck Fan Corporation.
  4. Hartzell Fan Incorporated.
  5. JencoFan.
  6. Loren Cook Company.
  7. PennBarry.
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  2. Companion Flanges: For inlet and outlet duct connections.
  3. Fan Guards: 1/2- by 1-inch (13- by 25-mm) mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
  4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

## **2.3 PROPELLER FANS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Manufacturing Corporation.
  2. Aerovent; a division of Twin City Fan Companies, Ltd.
  3. Carnes Company.
  4. Greenheck Fan Corporation.
  5. Hartzell Fan Incorporated.
  6. JencoFan.
  7. Loren Cook Company.

8. PennBarry.
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- E. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- F. Fan Drive:
  1. Resiliently mounted to housing.
  2. Statically and dynamically balanced.
  3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
  4. Extend grease fitting to accessible location outside of unit.
  5. Service Factor Based on Fan Motor Size: 1.4.
  6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
    - a. Ball-Bearing Rating Life: ABMA 9,  $L_{10}$  of 100,000 hours.
8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
9. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories:
  1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
  2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
  3. Wall Sleeve: Galvanized steel to match fan and accessory size.
  4. Weathershield Front Guard: Galvanized steel with expanded metal screen.
  5. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  6. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
- H. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.



2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- I. 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. Vibration- control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

### **3.2 CONNECTIONS**

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

**3.3 FIELD QUALITY CONTROL**

- A. Perform tests and inspections: Refer to Specification Section 019113, General Commissioning Requirements..
  - 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.

**3.4 ADJUSTING**

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

**END OF SECTION 23 3423**

**SECTION 233521****SLIDING BALANCER TRACK VEHICLE EXHAUST REMOVAL SYSTEM  
Pneumatic Grabber®****PART 1: GENERAL****1.01 RELATED DOCUMENTS**

- A. Conditions of the Contract and portions of Division One of this Project Manual apply to this Section as though repeated herein.

**1.02 SUMMARY**

- A. Provide all labor, materials, and equipment necessary to put in working operation a complete turnkey vehicle exhaust removal system to remove both diesel and automotive exhaust gases and particulate of operating vehicles within the confines of specified fire station(s). All necessary controls, motors, fittings, ductwork, blower(s), labor and all other equipment and materials specified shall be part of the work.
- B. Section Includes:
1. Manufacturer
  2. Sliding Track
  3. Support Legs
  4. Double Track Joiner Plate
  5. Track Splicing Assembly
  6. Riser Clamp Assembly
  7. Trolley/Balancer Assembly
  8. Regulator Assembly
  9. Uncoupling Valve Assembly
  10. Upper Flexible Hose
  11. Mid Hose
  12. Lower Hose Assembly
  13. Safety Disconnect Coupling Handle
  14. Collection Nozzle Assembly
  15. Compressed Air Features
  16. Hose Saddle
  17. Electrical Controllers
  18. Electrical System
  19. Air Moving Devices
  20. Ductwork System
- C. All items of equipment and materials described in these specifications are to be furnished installed and placed into proper operating condition in accordance with good practice and manufacturer's written or published instructions.
1. The exhaust removal system shall provide virtually 100 percent complete evacuation of all vehicle exhaust fumes at the source from start up to exit of the apparatus from the fire station. The vehicle exhaust removal system shall be capable of delivering complete coverage for bays up to 60 feet (18.3 m) in length. The system must be able to accommodate drive through and back-in bays to meet all the needs of the fire department.
  2. System must be designed and installed to NIOSH recommendation, specifying that occupational exposures to carcinogens be limited to the lowest feasible concentration. Exposure in the human breathing zone should be limited to lowest feasible level, without any time delay required for the system to effectively capture the diesel fumes.

3. System must also be capable to provide virtually complete capture and evacuation of carbon monoxide emitted as part of the vehicle exhaust.
4. Systems that solely use filters, in which diesel particulate may accumulate, and that would potentially have to be treated as hazardous materials, will not be accepted.
5. System must meet the guidelines for the International Mechanical code for Source Capture Systems. Such system is defined as a mechanical exhaust system designed and constructed to capture air contaminants at their source and to exhaust such contaminants to the outdoor atmosphere.
6. The system shall not affect personnel boarding the apparatus. Hose loops shall not hang any lower than six feet (1.8 m) from the bay floor. The hose assembly shall not come into contact with the vehicle other than one connection point to the vehicles tailpipe. The hose assembly shall not touch or drag on the bay floor.
7. The exhaust system shall not block doorways, exits, and aisles in the apparatus bay, which could endanger the welfare of fire personnel or visitors.
8. The exhaust system shall not need to be disconnected from the vehicle while shore lines are connected, during battery charging, or washing of the vehicle, as with other types of systems.
9. To protect the apparatus electrical system from possible damage, the system bid shall not incorporate any type of electromagnetic device that requires the apparatus to be utilized as an electrical ground for systems operation.
10. Due to the harmful effects of diesel exhaust, the system must be designed and capable of capturing virtually 100% of the exhaust gas and virtually 100% of the particulate even in the event of a complete power failure. The system shall not detach itself from the apparatus for any reason during a power failure other than normal exiting of the apparatus bay. System shall discharge exhaust outside the station even in the event of a power failure.
11. The system shall capture the exhaust gases and particulate directly from the tailpipe of the apparatus by a direct connected ~~%~~visible+high temperature rated hose. Particulates emitted from the apparatus are known to be heavier than air and therefore must be captured by a directly connected hose with a tight seal, as loose nozzles or air filters cannot capture these heavy particulates. The particulates have been documented to be the main respirable carcinogen in diesel exhaust, and therefore are the primary concern of the fire department to capture virtually 100% of these particulates.

### 1.03 SUBMITTALS

- A. Product Data: Indicate manufacturer's model number, technical data including description of components and static pressure/air flow chart, and installation instructions.
  1. Details of wiring for power differentiating between manufacturer-installed and field-installed wiring.
- B. Closeout Submittals: Operation and Maintenance data manual including spare parts list.

### 1.04 QUALITY ASSURANCE

- A. Engage a factory certified installer to perform work of this Section who has completed installations similar in design and extent to that indicated for this Project, and who has a record of successful in-service performance. No Exceptions.
- B. The manufacturer must be a ISO 9001:2008 certified [www.iso.org](http://www.iso.org) manufacturer with certification issued to a United States facility, this shows a commitment to delivering the highest quality service and products to the end user. Manufacturer shall be UL and CUL Certified [www.ul.com/database/](http://www.ul.com/database/) and certified by the Air Movement and Control Association (AMCA) [www.amca.org/search.htm](http://www.amca.org/search.htm) to ensure quality, consistency and reliability of products. All certification documents shall be provided and attached to the bid proposal. No exceptions.

- C. The manufacturer shall be DRC Conflict Free. Manufacturers shall only supply products that do not contain minerals that directly or indirectly finance or benefit armed groups in the Democratic Republic of the Congo or an adjoining country. Please refer to the Dodd-Frank Wall Street Reform and Consumer Protection Act, Section 1502.
- D. Engage a firm experienced in manufacturing vehicle exhaust removal systems similar to that indicated for this project and with a record of successful in-service performance.
- E. Conduct conference at project site. Review methods and procedures related to vehicle exhaust removal system installation.
  - 1. Review access requirements for equipment delivery.
  - 2. Review equipment storage and security requirements.
  - 3. Inspect condition of preparatory work performed by other trades.
  - 4. Review structural loading limitations.
  - 5. Review that all components specified in this Section and related components specified in other Sections are accounted for.

#### **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Packing, Shipping, Handling and Unloading: Deliver components with protective packaging. Store in original protective crating and covering and in a dry location.

#### **1.06 PROJECT/SITE CONDITIONS**

- A. Existing Conditions: Verify dimensions installation areas by field measurements.

#### **1.07 COORDINATION**

- A. Coordinate layout and installation with other work, including light fixtures, fixed equipment and work stations, HVAC equipment, radiant tube heaters and fire-suppression system components.
- B. Coordinate location and requirements of service-utility connections.

#### **1.08 REFERENCES**

- A. Air Movement & Control Association International, Inc.
  - 1. AMCA Standard 500-D-98, "Laboratory Methods of Testing Dampers for Rating".
- B. ASTM International.
  - 1. Stainless Steel:
    - a. A240/A240M-04ae1 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
    - b. Bright, Directional Polish: No. 4 finish.
  - 2. Aluminum:
    - a. B209/209M-04 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
    - b. Powder-Coated Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard baked-polymer thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.
  - 3. Galvanized Steel:
    - a. A653/A653M-04a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

**1.09 BIDDER QUALIFICATIONS**

- A. Bids will only be accepted from companies that have an established reputation in the business of system design, turnkey installation and long-term service of Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than five (5) years. Bidder shall be a registered corporation, partnership or sole proprietorship within the State where the installation is to take place. Bidder must have a current and valid state contractor's license, if required by the state for the work that is being bid. Bidder shall show proof that the system specified in this Bid Document has been field tested and proven by supplying a list of references with no less than 50 fire stations with systems installed by bidder (with comparable emergency and non-emergency run rates) within a 200 mile (322 km) radius of municipality seeking bid. References shall be submitted with the Bid Document and shall include phone numbers and contact names.

**1.10 MANUFACTURER QUALIFICATIONS**

- A. Bids shall only be accepted by bidders supplying equipment from manufacturers that have an established reputation in the business of manufacturing Automatic Emergency Response Vehicle Exhaust Removal Systems for a minimum of no less than fifteen (20) years. The manufacturer must be a ISO 9001:2008 Certified in the United States [www.iso.org](http://www.iso.org), UL and CUL Certified [www.ul.com/database/](http://www.ul.com/database/) and certified by the Air Movement and Control Association (AMCA) [www.amca.org/search.htm](http://www.amca.org/search.htm) to ensure quality, consistency and reliability of products. Certification documents shall be provided and attached to the bid proposal. No exceptions. Where the requirement calls for a packaged exhaust system to be provided, all items shall be the product of the manufacturer. The product offering must be a product that has been offered by that manufacturer for a minimum period of fifteen (20) years. No prototypes or private label products by other manufacturers will be allowed. System bid shall have a life of service of no less than 10 years to establish proof of quality, longevity and service. No exceptions.

**PART 2: PRODUCTS****2.01 MANUFACTURER**

- A. Plymovent Corporation  
5 Corporate Drive  
Cranbury, New Jersey 08512  
USA  
Telephone: (609) 395-3500  
Toll Free: (800) 644-0911  
FAX: (609) 655-0569  
WEB: [www.plymovent.com](http://www.plymovent.com)  
EMAIL: [info.usa@plymovent.com](mailto:info.usa@plymovent.com)

Local Sales Contact;

Air Cleaning Technology  
7900 Kincannon Pl.  
Lorton, VA. 22079  
email [tom2lax@gmail.com](mailto:tom2lax@gmail.com)  
Phone (703) 642-0962  
Fax (703)642-1538

## 2.02 SLIDING TRACK

- A. A one-piece continuous extruded aluminum track in a minimum length of 19 ft. (5.8 m). Profile shall be of a Boxloc type profile, track height 3 inches (73.4 mm), track width 1 ½ inches (38.1 mm), track thickness ¼ inch (3 mm); aircraft aluminum alloy Type EN-AW 6060 T6. Track: Extruded design that shall incorporate three separate and functioning channels. Channels: Include the mounting channel, the trolley channel and the Boxloc channel. Mounting Compartment: Designed to accept the slider bars (which shall be provided with factory supplied vertical support legs and riser clamp duct connection) and to allow positioning along the full length of the slotted track-mounting channel. Trolley Channel: Allow the trolley/balancer/ hose assembly to glide to the door threshold in a safe and effective manner. Boxloc Channel: Allow the whole track to remain rigid as it hangs from factory supplied leg supports and also shall provide an area to attach bolts for splicing additional tracks together for systems over 19 feet (5.8 m) long. The overall extruded track lengths shall be 19 feet (5.8 m) standard and shall weigh no more than 35 pounds (15.9 kg). The track system shall be equipped with end stops that limit travel of flex hose as the vehicle exits the building. The end stop shall be fabricated of zinc plated steel in a U shape form with a rubber end stop on the impact end. It shall be attached by using a ¼ inch (6.4 mm) molded locking bolt. The end stop shall be secured to the track with no less than (2) ¼ inch (6.4 mm) bolts and locking nuts located on the underside of the track. For security, a ¼ inch (6.4 mm) bolt shall be drilled through the ends of each track system and secured with a nyloc nut to ensure that the trolley/balancer assembly(s) roll no further than the end of the track system.

## 2.03 SUPPORT LEGS

- A. Support Leg and Mounting Feet: Manufactured and provided by the supplier of primary exhaust removal system (Equipment Manufacturer). Leg Material: Aircraft aluminum alloy Type AA-6063 (ASTM B209/B209M). Supports shall come standard in 19 feet (5.8 m) lengths. A minimum of one support with appropriate bracing shall be provided for every 10 linear feet (3.0 m) of track profile. The support legs shall consist of a square tubular profile with dimensions no less than 2 inch (50.8 mm) OD X 0.1 inch (2.5 mm) with ¼ inch (10 mm) fastening hardware provided. Vertical Adjustable Mounting Foot: Capable of attaching the leg assembly to a ceiling with a 30 degree pitch, complete with a slider bar and ¼ inch (10 mm) hardware necessary for mounting the horizontal track to the mounting channel system. Horizontal Adjustable Mounting Foot: Capable of attaching the leg assembly to a wall, complete with a slider bar and ¼ inch (10 mm) hardware necessary for mounting the horizontal track to the mounting channel system. Support Leg: Equipped with round tubular zinc-plated steel knee brace with pressed ends in standard lengths of 20 inches (508 mm), 30 inches (762 mm) and 72 inches (1.8 m). Angle completely adjustable to the leg support and mounted perpendicular and parallel to direction of the track. Typical Support Angle: 45 degrees from the centerline of the factory provided support leg. The standard leg shall be capable of meeting a Seismic 4 requirement. Uni-strut, all-thread rod, and/or chains may not be used in place of a leg assembly as sole support of the system. A minimum of one support with appropriate bracing shall be provided for every 10 (3 m) to 12 linear feet (3.7 m) of rail profile.

## 2.04 DOUBLE TRACK JOINER PLATE

- A. Joiner Plate: Constructed from a minimum of ¼ inch (6.4 mm) thick zinc-plated steel, designed to connect two parallel tracks to make a double track system to accommodate an apparatus bay over 40 feet (12.2 m) in length. Joiner Plate: 10 inch (254 mm) by 8 inch (203.2 mm) flat zinc-plated steel and designed to attach the two tracks to a single factory supplied support leg. The steel plate shall have (6) ¼ inch (10 mm) holes drilled 6 inches (175 mm) apart to accommodate the slider bar provided with factory support legs. Joiner Plate: Have two slider bars attached to the plate, located on the outside edges of the plate. These slider bars shall fit into the Boxloc track mounting channel for a simple and secure attachment of the plate to the Boxloc track. The center portion of the joiner plate shall provide attachment for the factory supplied support leg.

**2.05 TRACK SPLICING ASSEMBLY**

- A. Track Splice: Manufactured of galvanized steel (ASTM A653/A653M) in two parts and utilized as a clamping device. This clamp shall accurately secure both tracks together in a fashion, which shall eliminate any possibility of obstructing the trolley assembly as it passes through this connection point of track system. Connecting length of splice shall be a minimum of 15 ¾ inches (400 mm) long and fabricated of 12 gauge material. Four (4) ¼ inch (6 mm) bolts with nyloc nuts shall pass directly through internal partition of the Boxloc track. The splicing sleeve shall fit externally around the outside dimension of extruded aluminum track profile.

**2.06 RISER CLAMP ASSEMBLY**

- A. Riser Clamp: Fabricated as a one piece welded assembly, manufactured to create the transfer of the hard spiral pipe joined at the top and flexible duct connection at the bottom. The riser clamp shall be pre-drilled to mount an air regulator assembly for the pneumatic nozzle and to accept airlines that pass through airtight grommet seals mounted to riser pipe. A slider bar and associated hardware shall be provided with riser clamp assembly. Sizes of the riser clamp shall be 4 inch (100 mm) or 5 inch (125 mm) in diameter to match the output velocity of the vehicles that will park in that station.

**2.07 TROLLEY/BALANCER ASSEMBLY**

- A. Trolley Assembly: Manufactured as a two piece galvanized steel assembly including bumper stops at each end. Fixed to the side of the trolley are solid steel pins, which shall be for load carrying bearings that are sealed and permanently lubricated. The load carrying bearings shall travel internally in track trolley channel. Two additional permanently lubricated trolley wheels shall be provided on bottom side of the track to reduce wobble of trolley as it conveys the hose assembly to the door threshold. System Balancer Assembly: Self-adjusting weight spring tension balancer with a maximum lifting capacity of no less than 31 pounds (14 kg). The balancer shall have a minimum diameter stainless steel cable of .080 inch (2 mm), with a safety link connection.

**2.08 REGULATOR ASSEMBLY**

- A. Regulator: Designed to operate with an input pressure of 0 psi (0 bar)- 150 psi (10.3 bar); the output pressure shall be preset at 15 psi (1 bar). Regulator: Attached to each Riser Clamp Assembly/Hose Drop and to the Boxloc track to allow for independent adjustment of each pneumatic nozzle. The regulator shall also be provided with needle type adjustment gauge that is clearly marked with the proper operating range of the system and the gauge shall be visibly read from standing on the bay floor.

**2.09 UNCOUPLING VALVE ASSEMBLY**

- A. Uncoupling Valve Assembly: Provided to activate the release of the pneumatic nozzle collection to the vehicle exhaust pipe, single direction action and affixed to a mounting bracket, which can be easily positioned and adjusted along the full length of the extruded aluminum track profile. Mounting Bracket: Formed from a minimum of 16 gauge galvanized steel and designed to fit snugly over the top of the Boxloc track system. A ¼ inch (6 mm) opening shall be centered to the top side of bracket to accommodate a ¼ inch (6 mm) by 1 inch (25 mm) bolt with a ¼ inch (6 mm) thick plated 1 ½ inch (38 mm) long bar providing the secure attachment of the uncoupling valve. When the system is put into service the release valve shall be set for the maximum exiting speed of the vehicle.

**2.10 UPPER FLEXIBLE HOSE**



- A. Upper Flexible ST (Standard Temperature) exhaust hose manufactured for the sole purpose of venting high temperature exhaust gases. Flexible Upper Hose: Designed strictly for the harsh environment of rapid response and auto-release of a vehicle exhaust tailpipe. Hose: Shall be 4 inch (100 mm) or 5 inch (125 mm) diameters with lengths of 15 ft. (4.5 m), 20 ft. (6.1 m), 24 ft. (7.3 m), 29 ft. (8.8 m), and 34 ft. (10.4 m) without joining or splicing connections. Hose Material: High temperature synthetic rubber impregnated into a high temperature laminated fabric with a mechanically crimped connection around a coated steel wire. This construction of hose must be capable of operating at continuous temperatures of 400° F (204° C) and intermittent temperatures of 500° F (260° C), such as are experienced when pump checks are performed inside the fire station. Protective Clip Cover: This shall be accomplished in a fashion, which eliminates any possibility of personnel coming in contact with an exposed hot metal helix and be provided in a safety yellow color. The bend radius of the high temperature hose shall be no less than 1.5 times the diameter of hose to ensure that hot gases are not restricted as they pass through the system. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard and/or shock hazard from being utilized as a grounded, grounding or current carrying conductor for electromagnet connections. **No exceptions will be allowed.**
- B. Optional Upper Flexible HT (High Temperature) exhaust hose manufactured for the sole purpose of venting high temperature exhaust gases. Flexible Upper Hose: Designed strictly for the harsh environment of rapid response and auto-release of a vehicle exhaust tailpipe. Hose: Flexible 4 inch (100 mm) or 5 inch (125 mm) diameter with total lengths of 15 ft. (4.5 m), 20 ft. (6.1 m), 24 ft. (7.3 m), 29 ft. (8.8 m), and 34 ft. (10.4 m) long section of yellow and black hose identical in appearance to the mid and lower hose assembly and extending from the metal saddle to the riser bracket. This construction of hose must be capable of transporting exhaust at continuous temperatures of 900° F (482° C) and intermittent temperatures of 1,050° F (566° C). **An independent third party test report shall be submitted with bid as proof of claim.** Wire Helix: Bound and protected in laminations of high temperature material. This shall be accomplished in a fashion, which eliminates any possibility of personnel coming in contact with an exposed hot metal wire helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. High Temperature Wear Strip: 9/16+inch (14.2 mm) wide and be provided in a safety yellow color. Hoses utilizing an exposed metal helix will not be acceptable due to potential personnel burn hazard. **No exceptions will be allowed.**

## 2.11 MID HOSE

- A. ST (Standard Temperature) Mid Hose: Designed strictly for the harsh environment of rapid response and auto-release from a vehicle exhaust tailpipe. Semi rigid hose: Shall be 4 inch (100 mm) or 5 inch (125 mm) diameter by 10 ft. (3 m) long section of yellow and black hose identical in appearance to the lower hose assembly and extending from the metal saddle to the SDCH. Hose Material: High temperature synthetic rubber impregnated into a high temperature laminated fabric with a minimum overlapping thickness of 2 7/16+ inches (62 mm). This construction of hose must be capable of operating at continuous temperatures of 400° F (204° C) and intermittent temperatures of 500° F (260° C), such as are experienced when pump checks are performed inside the fire station. **An independent third party test report shall be submitted with bid as proof of claim.** Wire Helix: Bound and protected in laminations of hose winding. This shall be accomplished in a fashion, which eliminates any possibility of personnel coming in contact with an exposed hot metal helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. Wear Strip: 9/16+inch (14.2 mm) wide and be provided in a safety yellow color. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard and/or shock hazard from being utilized as a grounded, grounding or current carrying conductor for electromagnet connections. **No exceptions will be allowed.**
- B. Optional HT (High Temperature) Mid Hose: Designed strictly for the harsh environment of rapid response and auto-release from a vehicle exhaust tailpipe. Flexible hose: Shall be 4 inch (100 mm) or 5 inch (125 mm) diameter by 10 ft. (3 m) long section of yellow and black hose identical in appearance to the lower hose assembly and extending from the metal saddle to the SDCH. This construction of hose must be capable of

transporting exhaust at continuous temperatures of 900° F (482° C) and intermittent temperatures of 1,050° F (566° C). **An independent third party test report shall be submitted with bid as proof of claim.** Wire Helix: Bound and protected in laminations of high temperature material. This shall be accomplished in a fashion, which eliminates any possibility of personnel coming in contact with an exposed hot metal wire helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. High Temperature Wear Strip: 9/16+inch (14.2 mm) wide and be provided in a safety yellow color. Hoses utilizing an exposed metal helix will not be acceptable due to potential personnel burn hazard. **No exceptions will be allowed.**

## 2.12 LOWER HOSE ASSEMBLY

- A. ST (Standard Temperature) Lower Hose: Rigid 4 inch (100 mm) or 5 inch (125 mm) diameter by 2 ft. (610 mm) long section of yellow and black hose identical in appearance to the upper hose assembly. This construction of hose must be capable of operating at continuous temperatures of 400° F (204° C) and intermittent temperatures of 500° F (260° C) such as are experienced when pump checks are performed inside the station. **An independent third party test report shall be submitted with bid as proof of claim.** Supports the pneumatic connection nozzle and stainless steel reducing elbow in a rigid fashion to allow for the operator to place hose collection nozzle onto the tailpipe without bending over. The lower hose is the only section of hose which shall disconnect from the upper hose assembly and act as a safety disconnect in the unlikely event the nozzle gets entangled. Hoses utilizing an exposed metal helix will not be acceptable due to potential burn hazard. **No exceptions will be allowed.**
- B. Optional HT (High Temperature) Lower Hose: Semi-rigid 4+inch (100 mm) or 5+inch (125 mm) diameter by 2 ft. (610 mm) long section of yellow and black hose identical in appearance to the upper hose. This construction of hose must be capable of transporting exhaust at continuous temperatures of 900° F (482° C) and intermittent temperatures of 1,050° F (566° C). **An independent third party test report shall be submitted with bid as proof of claim.** Wire Helix: Bound and protected in laminations of high temperature material. This shall be accomplished in a fashion, which eliminates any possibility of personnel coming in contact with an exposed hot metal wire helix. The hose shall further protect the internal wire helix from heat buildup and in turn add increased visibility to personnel. High Temperature Wear Strip: 9/16+inch (14 mm) wide and be provided in a safety yellow color. Shall support the pneumatic collection nozzle and stainless steel reducing elbow in a semi rigid fashion to allow for the operator to place hose collection nozzle onto the tailpipe without bending over. The lower hose is the only section of hose which shall disconnect from the upper hose assembly and act as a safety disconnect in the unlikely event the nozzle gets entangled. Hoses utilizing an exposed metal helix will not be acceptable due to potential personnel burn hazard. **No exceptions will be allowed.**

## 2.13 SAFETY DISCONNECT COUPLING HANDLE

- A. Safety Disconnect Coupling Handle (SDCH): An injection molded composite body with a 4+inch (100 mm) or 5+inch (125 mm) diameter hose connection. A 360 degree rubber bumper to protect the vehicle and disconnect from wear shall be incorporated in the design of the system. Coupling: Consists of a aluminum inner flange collar connected by a patented easy reconnect mechanism. The release tension of this device shall be preset at 84 pounds of force (375N). And easily reconnected with only 3 pounds of force (13N).
- B. Manual Fill and Deflation Valve: Integrated into the SDCH body, sliding/push button type valve for manual or automatic release of the collection nozzle. In its design this valve shall be incorporated into the design of the handle which the operator may easily operate in a standing position. The attachment of the pneumatic collection nozzle shall not position the operator's breathing zone closer than 36 inches (914 mm) from the exhaust tailpipe. The automatic release of the connection valve shall be no greater than 3 psi (.2 bar). shift pressure to activate the automatic nozzle deflation. Primary Air Supply: Accomplished by means of a quick

connect type fitting. The regulated air supply line to collection nozzle shall be designed to safely release from the upper hose at a pressure no greater than 80 pounds of force (356N).

#### 2.14 COLLECTION NOZZLE ASSEMBLY

- A. Collection Nozzle Assembly: Provides a substantially air tight seal around exhaust tail pipe when connected thus allowing for virtually 100% source capture. The seal shall limit escape of life threatening exhaust gases.
- B. The Pneumatic Nozzle Assembly: Automatically adjust its internal orifice to accept any tailpipe ranging from 2 inch (50 mm) through 6 inch (150 mm) diameter. Nozzle Pressure: Not to exceed 15 psi (1 bar) when connected to the vehicle's tailpipe. Nozzle Construction: High temperature synthetic rubber vulcanized to a high temperature synthetic fabric. The reducing elbow that connects to the collection nozzle shall be fabricated using continuous welded construction and shall be made from polished 304 stainless steel. The angle of transition shall be no less than or greater than 67 degrees from the centerline of the reducer. The stainless steel reducer shall incorporate a primary expanded metal debris screen, which is permanently affixed by welded seams to the inside opening of exhaust fitting. Since this item is a point of safety for both personnel and the system itself. **No exception will be allowed.**
- C. Provide five (5) 4+adaptor assemblies to be used with the existing Plymovent System to accommodate smaller vehicles. Coordinate with owner prior to ordering.

#### 2.15 COMPRESSED AIR FEATURES

- A. Airlines: ¼ inch (6mm) OD tubing capable of exposure to high temperature air stream inside the ventilation hose and duct. Airlines: Fed through the duct riser bracket utilizing high temperature rubber grommets to protect against abrasion. Unless a fire station air compressor is to be utilized the bidder shall provide a quiet operating compressor to be located proximate to the vehicle bays. It shall also be located so that preventative maintenance can be performed quickly and effectively. The operation of the compressor running inside the station shall not generate sound decibels in excess of 82 dBA. The compressor shall be equipped with a filter/dryer regulator to ensure the conveyance of clean dry air to the pneumatic controls incorporated in the auto-release ventilation system.

#### 2.16 HOSE SADDLE

- A. Metal Hose Suspension Saddle: Fabricated of steel and powder coated with a black matte finish specifically manufactured for the sole purpose of suspending high temperature exhaust ventilation hose in a rapid response and auto-release application. The design of the saddle shall smoothly transition the direction of the hose during its travel along the track. A fire sleeve type insulator shall be utilized to protect the Teflon airlines where they contact the metal hose saddle. Securing clamps shall be provided including a link fastener, for the purpose of attaching it to the balancer or swivel cable.

#### 2.17 ELECTRICAL CONTROLLERS

- A. Controller: Built and supplied by a UL and CUL recognized and listed exhaust system manufacturer. Controller shall carry the UL and CUL listing label as an ~~Enclosed~~ Industrial Control Panel. Individual components listed by UL and CUL shall not satisfy the above requirement. Manufacturer shall undergo quarterly inspections by UL to verify all requirements and standards are met as outlined by UL and CUL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications to follow.

- B. Electrical Controllers:** Bear a visible UL and CUL listing label as proof of subscribership and shall be validated by UL [www.ul.com/database/](http://www.ul.com/database/) as an Enclosed Industrial Control Panel+. Certification documents shall accompany bid documents.
1. Manufacturer Name: \_\_\_\_\_
  2. UL File No.: \_\_\_\_\_
  3. Electrical controller and manufacturer shall be recognized and listed by UL and CUL. Controller shall be manufactured in accordance with Underwriters Laboratories standard UL-508A for Enclosed Industrial Control Panels+. The electrical controller shall include a Class 1 limited energy control circuit. Enclosures shall be NEMA 12 rated and UL listed as Type 12. The electrical control components shall be provided and mounted in an electrical enclosure to restrict access to internal components of the controller by authorized personnel only.
- C. Controller Performance:** Designed to sense the output pressure and/or temperature change inside the ductwork system, which is normally generated by any internal combustion engine designed to propel a motor vehicle. The operating logic shall be designed to complete this cycle. At any point in time when a collection device is connected to a motor vehicle's exhaust tailpipe, as the operator starts the vehicle, the controller shall automatically sense the engine's output pressure or temperature of the exhaust and in turn energize the electrical contactor which will supply power to the AMCA certified spark resistant fan. Through the use of an adjustable timer the controller shall keep the contactor energized for up to four minutes in accordance with the stations response requirement. If the responding vehicle does not disconnect from the exhaust ventilation system in less than the designated setting, the optional temperature override switch shall override the time delay to ensure continuous system operation. This automated function will work for as long as the exhaust gas temperature is in excess of the setting on the heat sensor located in the ductwork system. This cycle shall not allow the electrical contactor, which energizes the exhaust fan, to short cycle or stop the fan while the system is connected to an operating vehicle.
- D. Motor Control Contactor:** Allen Bradley Industrial Electrical Contactor 100C series. The contactor shall be UL - CUL listed as an approved component.
- E. Motor Control Overload Relay:** Allen Bradley 193 E1 Plus series. Overload relay shall have an adjustable trip range to meet the proper full load amperage of the blower motor.
- F. Soft Touch Controls:** Incorporated on the face or the access door of the controller by the use of an adhesive backed Lexan membrane type label to prevent water infiltration, which would void the NEMA 12 rating. Label: Provided and secured permanently to the exterior of the electrical controller. Label: Includes the name of the manufacturer, address, telephone number, user instructions and any warnings or cautions required by Underwriters Laboratories.
1. Auto Start: This mode of operation shall be strictly for normal day to day use, as it would apply to receiving an emergency call and leaving the station. Any one or combination of the three devices listed below in Paragraph K shall activate the system. The system shall maintain itself in the Auto Start mode and always return there after the Stop sequence has been initiated. The controller shall not have a permanent off position due to the potential health hazards of diesel exhaust components.
  2. Stop: This mode of operation shall be a system override to shut down the system manually. Upon activating this mode of operation the exhaust system blower shall shut down. After a period not to exceed three seconds the controller shall automatically return to the Auto Start ready mode. This shall be a safety feature to prevent a potential health hazard from carcinogenic diesel exhaust leakage from systems having an undesirable open nozzle.
  3. Manual Run: This mode of operation shall be a system override to run the exhaust system blower continuously for the purpose of running the vehicles indoors for equipment checks during inclement weather. Upon activating this mode of operation the exhaust system blower shall start and run continuously until the Stop mode is activated at which point the system will automatically return to the Auto Start ready mode within a maximum three second time period.

- G. System Indicator LEDs:** Show system status at all times.
1. Auto Start Indicator: Indicate the system is in the fully automatic mode of operation and that power is on to the controller.
  2. Fan On Indicator: Indicate that power is being applied to the system blower and the controller is operating normally.
  3. Filter Status Indicator: Indicates, if flashing, excessive pressure loss across the optional filter bank media. Consequently the filter must be serviced to maintain optimum efficiency of the system.
  4. Stop Indicator: Indicate the fan has been manually de-energized and will return to the Auto Start ready sequence in less than three seconds to prevent the system blower from being left in the Off mode.
  5. Manual Run Indicator: Indicate the fan is operating in a continuous run mode until interrupted by the stop mode activation.
- H. Controller Transformer:** UL listed industrial control circuit transformer sized to properly supply all components so that only one transformer shall be required. Transformer shall be provided with multi-tap primary for 115, 208, 240, 277, 400, 480, and 600VAC, and 24 VAC secondary operating on 50 or 60 hertz with a capacity of 35 volt amperes.
- I. Control Circuit Protection:** By the use of primary and secondary fuses to meet UL and CUL requirements. The primary shall be protected by a pair of FLQ style fuses. A single GMA style glass fuse rated at 3.15 amps at 250V shall protect the secondary side of the control circuit.
- J. Electronic Control Circuit Card:** Solid state printed circuit board. The soft touch controls shall be an integral part of the control circuit card. The control circuit card shall utilize a potentiometer to adjust the length of the timing cycle up to 4 minutes. It shall incorporate several different modes of operation and optional features.
- K. Activation Devices:**
1. Engine Start Switch: An engine pressure sensing type, capable of recognizing the output pressure of any type of motor vehicle exhaust. The electrical contact shall be dry type and not to exceed 24VAC. There shall be one sensor per vehicle.
  2. Optional Thermal Start Switch: Temperature sensing switch of the snap disc type and adjustable from 90° F (32° C) to 130° F (55° C) to configure the system based on different exhaust temperatures. There shall be one sensor per vehicle if chosen.
  3. Wireless Transmitter and Receiver System: Shall be an optional feature operating on a 2400 MHz frequency. Complies with FCC rule part 15, FCC ID: UY124. The receiver shall utilize 3 independent channels of control and capable of supporting up to 60 transmitters. The receiver shall operate on 12-24 VAC or VDC and enclosed in a non-metallic enclosure with a clear see through lid to view system supervisory functions. The transmitter shall be programmable and shall be powered by a 3 year battery for ease of replacement and cost savings. The transmitter shall have an open field range of 1000 feet (305 m) and shall be initiated by a NO contact closure such as from a pressure switch mounted on the exhaust system or a relay mounted in the vehicle.
- L. Clean Filter Indicator Alarm:** Used in conjunction with an optional Unifilter for filtering diesel exhaust particulate before release to the atmosphere. The clean filter indicator shall monitor the pressure loss across the filter bank media. Once the useful life of the filter has been depleted the pressure differential switch will signal a high-pressure loss and flash the Fan On indicator while the exhaust blower is running.
- M. Optional System Monitor:** Shall be an optional feature to monitor the system and advise when a preset number of emergency runs or run time on the system have accrued.
- N. Optional No Airflow Alarm:** Shall be an optional feature to monitor the system and advise when the exhaust fan is not functioning properly.

- O. Optional Carbon Monoxide Alarm: Shall be an optional feature to monitor the carbon monoxide levels inside the apparatus bay area.
- P. Electrical Wiring: Run in wire channel to allow for easier identification of the wiring circuits and for a neat appearance. All wiring circuitry shall meet National Electric Code and UL and CUL standards for proper size, bending radiuses and terminations.
- Q. Electrical Terminal Block: 600 V, UL and CUL rated and recognized. It shall provide individual connection points for remote controls, clean filter indicator and power connections. The primary and secondary control wiring fuses shall be incorporated into the terminal block as one unit.
- R. Product Manual: Shall be provided with each electrical control box supplied. The product manual shall include a description of components with part numbers inclusive to the controller. It shall include a wiring schematic showing all internal circuitry as well as all field installed wiring connections to the controller.
- S. Electrical Interference: To protect the apparatus and communications, designs that allow any possibility of electrical back-feed or induced current which may interfere with a central services communication or onboard vehicle computer logic or navigational equipment will not be accepted.

## 2.18 ELECTRICAL SYSTEM

- A. Station Electric Supply Panel: The power circuit for the %Emergency Response Vehicle Exhaust Removal System+ shall originate in a circuit breaker panel board of the appropriate size to handle the load. Fan circuit shall be supplied by a UL listed, HACR rated circuit breaker (HACR rating is specifically for motor type loads) of the same type as indicated by the manufacturer of the circuit breaker panel or a dual element time delay fuse for fuse style panels. The circuit shall be clearly marked on an engraved ledger plate or in ink on the panel schedule as %Emergency Response Vehicle Exhaust Removal System+.
- B. OS-3 Automatic Controller: Built and supplied by a UL recognized and listed exhaust system manufacturer. Controller shall carry the UL - CUL listing label as an %Enclosed Industrial Control Panel+. Individual components listed by UL shall not satisfy the above requirement. Manufacturer must undergo quarterly inspections by UL to verify all requirements and standards are met as outlined by UL and CUL. The controller shall be delivered as an Operating System Three series controller or an approved equal to the specifications in 2.15 Electrical Controllers. The controller shall be mounted 6 feet (1.8 m) to the top of the cabinet AFF (above finished floor). A safety disconnecting means must be within sight of the controller for servicing and for safety reasons. If the supply panel is not within sight, a separate disconnecting means is required beside the controller (per NEC Code 2014). Safety disconnect shall be capable of being locked in the off position to follow lockout, tag out procedures.
- C. Power Wiring Conduit: Minimum of EMT utilizing fittings for damp locations such as apparatus wash down areas (per NEC Code 2014). Conduit shall be supported with a conduit strap every 10 ft. (3 m) and within 3 feet (1 m) of each box or termination, (per NEC 2014).
- D. Power Wiring from Supply Panel to OS-3: THHN stranded copper wire consisting of a flame retardant, heat-resistant thermoplastic insulation with a nylon jacket for abrasion, gas, and oil resistance and rated up to 600 volts or similar.
- E. Low Voltage Control Wiring: Minimum of a 16/2 multi-conductor cable to meet UL standards for the controllers low voltage field wiring.

- F. Low Voltage Control: Encased in a minimum of ½ inch (12.7 mm) EMT from the OS-3 Controller to the attic or building steel where it shall terminate with a EMT connector with a threaded plastic bushing. Conduit: Supported with a conduit strap every 10 feet (3 m) and within 3 feet (1 m) of each box or termination (per NEC Code 2014). The 16/2 multi-conductor cable shall be supported by the building structure and ran in a manner that the cable will not be damaged by normal building use (per NEC Code 2014), securely fastening it with nylon tie wraps every 24 inches (610 mm) to 36 inches (914 mm). Draping of the cable perpendicular to building steel or support members will be unacceptable.
- G. Power Wiring from OS-3 to Fan Motor: Minimum of EMT utilizing compression type fittings for damp locations such as apparatus wash down areas (per NEC Code 2014). Conduit shall be supported with a conduit strap every 10 ft. (3 m) and within 3 ft. (1 m) of each box or termination (per NEC Code 2014). Conduit shall extend through the outside wall through a hole of the proper size and terminate directly into the back of the safety disconnect with the appropriate connector and sealed with a silicon sealer or cement mortar. (Using fan model number select appropriate wire from Table 1-1).
- H. Fan Safety Disconnect: Non-fusible, NEMA 3R rated for wet locations, mounted adjacent to the AMCA Certified blower. Safety disconnect shall be capable of being locked in the off and on position to follow lockout, tag out procedures (per NEC 2014).
- I. Liquid Tight Flexible Metal Conduit: UL listed liquid tight flexible metallic conduit (Sealtite). Conduit will encase the load wires and ground wire from the safety disconnect switch to the blower motor. Conduit length not to exceed 4 feet (1.2 m) from disconnect to blower motor. The appropriate listed terminal fittings shall be used (per NEC Code 2014).
- J. Spark Resistant Blower: AMCA certified, designed and installed as a direct drive spark resistant blower. The motor shall meet current EPACT standards for energy savings. Fans utilizing belt drives and steel impellers will not be accepted.
- K. Optional Temperature Switch: One for each apparatus connected to the system. The temperature switch shall be of the snap disc type and adjustable from 90° F (32° C) to 130° F (54° C). It shall be mounted on the ductwork 2 inches (50 mm) above the pressure switch by drilling a 1 inch (25 mm) hole, sealing the switch with silicone sealant and securing with 2 self drilling screws. Electrical connection shall be made with terminals provided or solder less type such as Thomas & Betts part no. 14RB-2577 or equivalent.
- L. Pressure Switch: One for each apparatus connected to the system. The pressure switch shall operate at a maximum of 24VAC, pre-calibrated at .18 in. of water column. Mounting shall be accomplished by drilling a 1 inch (9.5 mm) hole 3 inches (76.2 mm) above the riser bracket and to the left of the regulator and threading the switch into the duct. The electrical connections shall be made with a 0.020 inch (.5 mm) by 0.187 inch (4.8 mm) female quick disconnect terminals, such as Thomas & Betts part no. 14RBD-18277 or equivalent.

# Fan Component Sizing Chart

**Table 1-1**

25

## Single Phase

Plymovent  Product  No.	Motor  Man- uf. **	HP  Rat- ing	Name Plate		NEC  Table 430.248 Amps	Wire Size THHN  AWG	Length of Wire in Feet  (Meters) Start to Fin- ish		Circuit  Breaker  Size
			Volt- age	FLA			From	To	
FUA-1301-AM	WEG	1/2	115	7.6	9.8	14	0	72 (21.9)	15A
			230	3.8	4.9	14	0	289 (88)	15A
FUA-1801-AM	WEG	3/4	115	10.6	13.8	12	0	82 (24.9)	20A
			230	5.3	6.9	14	0	207 (63)	15A
FUA-2101-AM	WEG	1.5	115	17	20	10	0	81 (24.6)	30A
			230	8.5	10	12	0	204 (62.1)	20A
FUA-2701-AM	WEG	1.5	115	17	20	10	0	81 (24.6)	30A
FUA-3001-AM			230	8.5	10	12	0	204 (62.1)	20A
TEV-359-60	WEG	2	115	20.4	24	10	0	68 (20.7)	30A
			230	10.2	12	12	0	170 (51.8)	20A
FUA-4701-AM TEV-3110-60	WEG	3	230	13.5	17	10	0	206 (62.7)	30A
			460	6.75	*	14	0	325 (99)	15A
TEV-559-60	WEG	5	230	21	28	8	0	211 (64.3)	30A
			460	10.5	*	14	0	209 (63.7)	15A
TEV-585-60	WEG	7.5	230	32	40	8	0	138 (42)	40A
			460	16	*	10	0	347 (105.7)	30A
TEV-745-60	WEG	10	208	43.2	55	4	0	234 (71.3)	60A
			230	38.8	50	6	0	181 (55.1)	50A
			460	19.4	*	10	0	286 (87.1)	30A

\* Note: 2014 NEC Table 430.248 does not list 460 volt single phase motors.

## Three Phase

Plymovent  Product  No.	Motor  Man- uf.	HP  Rat- ing	Name Plate		NEC  Table 430.250 Amps	Wire Size THHN  AWG	Length of Wire in Feet		Circuit  Breaker  Size
			Volt- age	FLA			(Meters) Start to Fin- ish		
							From	To	
FUA-1300-1- AM	WEG	1/2	208	1.78	2.4	14	0	644 (196.2)	15A
			230	1.61	2.2	14	0	788 (240.1)	15A
			460	.81	1.1	14	0	3,132 (954.6)	15A
FUA-1300-2- AM	WEG		575	.66	.9	14	0	4,805 (1464.5)	15A
FUA-1800-1- AM	WEG	3/4	208	2.41	3.5	14	0	476 (145)	15A
			230	2.18	3.2	14	0	581 (177)	15A
			460	1.09	1.6	14	0	2,327 (709.2)	15A
FUA-1800-2- AM	WEG		575	.876	1.3	14	0	3,620 (1103.3)	15A
FUA-2100-1- AM	WEG	1	208	3.17	4.6	14	0	361 (110)	15A
			230	2.87	4.2	14	0	442 (134.7)	15A
			460	1.43	2.1	14	0	1,774 (540.7)	15A



<b>FUA-2100-2-AM</b>	WEG		575	1.12	1.7	14	0	2,831 (862.8)	15A
<b>FUA-2700-1-AM FUA-3000-1-AM</b>	WEG	1.5	208	4.36	6.6	14	0	263 (80.1)	15A
			230	3.94	6	14	0	322 (98.1)	15A
			460	1.97	3	14	0	1,307 (398.3)	15A
<b>FUA-2700-2-AM FUA-3000-2-AM</b>	WEG		575	1.56	2.4	14	0	2,033 (619.6)	15A
<b>TEV-359-60</b>	WEG	2	208	6.25	7.5	14	0	183 (55.7)	15A
			230	5.65	6.8	14	0	224 (68.2)	15A
			460	2.83	3.4	14	0	896 (273.1)	15A
			575	2.06	2.7	14	0	1,539 (469)	15A
<b>TEV-3110-60 FUA-4700-1-AM</b>	WEG	3	208	8.4	10.6	14	0	136 (41.4)	15A
			230	7.6	9.6	14	0	166 (50.5)	15A
			460	3.8	4.8	14	0	667 (203.3)	15A
<b>FUA-4700-2-AM</b>	WEG		575	3.04	3.9	14	0	1,043 (317.9)	15A
<b>TEV-559-60</b>	WEG	5	208	13	16.7	10	0	223 (67.9)	30A
			230	11.8	15.2	12	0	170 (51.8)	20A
			460	5.9	7.6	14	0	430 (131)	15A
			575	4.72	6.1	14	0	671 (204.5)	15A
<b>TEV-585-60</b>	WEG	7.5	208	19.2	24.2	8	0	241 (73.4)	40A
			230	17.3	22	10	0	185 (56.3)	30A
			460	8.66	11	14	0	293 (89.3)	15A
			575	6.93	9	14	0	457 (139.2)	15A
<b>TEV-745-60</b>	WEG	10	208	25.8	30.8	8	0	179 (54.5)	40A
			230	23.4	28	8	0	218 (66.4)	40A
			460	11.7	14	12	0	343 (104.5)	20A
			575	9.35	11	14	0	339 (103.3)	15A
<b>TEV-768-60</b>	WEG	15	208	37.6	46.2	6	0	195 (59.4)	50A
			230	34	42	6	0	238 (72.5)	50A
			460	17	21	10	0	377 (114.9)	30A
			575	13.6	17	10	0	590 (179.8)	30A

**\*\*Note: Guidelines are subject to change without notice. Data supplied from our primary motor supplier. Please confirm at time of order. Plymovent assumes no liability for any electric installation, all local, city, and the 2014 National Electric Code must be followed. This chart is a minimum standard and to be used as a guideline only. Based on 3% voltage drop for branch circuits.**

## 2.19 AIR MOVING DEVICES

- A.** Centrifugal Fans: Direct drive centrifugal type, high pressure, single width, single inlet as required or indicated. Impeller Wheels: Radial design or backward incline for performance, spark resistant and made of a non ferrous material to prevent static electricity build up. The impeller shall be dynamically and statically balanced and of the non-overloading type to provide maximum efficiency while achieving quiet, vibration-free

operation. The fan housing shall be manufactured from a epoxy powder coated galvanized steel or nonferrous material. The outlet configuration shall be top horizontal, bottom horizontal, or upblast. The housing shall be capable of field reconfiguration in the event the mounting position needs to be changed for unforeseen reasons. The exhaust discharge outlet shall be in compliance with International Mechanical Code and ACGIH recommendations (min. of 36 inches (1 m) above roofline). Air intakes, windows, cascade systems, prevailing currents, communication equipment and building aesthetics shall be considered in the final location of the fan.

For aesthetic reasons the fan motor and assembly shall be mounted on a epoxy powder coated galvanized steel mounting base to prevent rust stains on the exterior of the building. Belt driven fans are unacceptable due to maintenance reasons and the potential for the fan to be left non-operational without warning.

- B. Fan Motor and Bearing: All ½ horsepower (373 watts) to 15 horsepower (11 kW) motors shall be totally enclosed fan cooled (TEFC) continuous duty rated. The motors shall be dual voltage where applicable. Motors shall comply with the government mandated Energy Policy and Conservation Act (EPACT) as outlined by the Department of Energy. The bearings shall be self-aligned, ball bearing type permanently sealed and lubricated.
- C. Performance: Lengths of ductwork, hoses, elbows, branches, wyes, etc. which increase the static pressure of the system, shall be taken into account to properly size the fan. The delivered volume shall be calculated taking into account the static regain of the vehicles engine exhaust (based on a virtually airtight connection at the tailpipe). The manufacturer's provided fan(s) shall be performance guaranteed by AMCA certification.
  - 1. Required Fan Capacity: The Fan Capacity shall be sized as such as to deliver the required CFM at each hose drop to which the vehicle is attached.
    - a. The 4 inch (100 mm) hose system shall be designed to deliver a minimum of 340 CFM (577 m³/h) at a velocity of 4500 FPM (23 m/s) at the hose and nozzle connection.
    - b. The 5 inch (125 mm) hose system shall be designed to deliver a minimum of 540 CFM (917 m³/h) at a velocity of 4500 FPM (23 m/s) at the hose and nozzle connection.
- D. Location: The preferable fan location shall be on the outside of the fire station as far away from any living quarters as possible so that firefighters would not be disturbed by the system activation. No blower fans shall be mounted inside the fire station. Silencers shall be provided when fan sound pressure level exceeds 64 dBA.

## 2.20 DUCTWORK SYSTEM

- A. Ductwork Type and Materials: UMC Class 2 or SMACNA Class II product conveying duct, meet or exceed criteria for construction and performance as outlined in Round Industrial Duct Construction Standards, SMACNA. Materials of construction unless otherwise specified for all ductwork and fittings shall be a minimum G-90 galvanized sheet metal (ASTM A653/A653M). Only when specified, Type 304 stainless steel (ASTM A240/A240M) shall be provided.
- B. Ductwork Sizing and Gauges: Round pipe construction, with the range of available sizes not to exceed 16 inches (406 mm) in diameter. Duct gauge shall depend on diameter and a minimum operating pressure of 8 inches of water gauge (1993 Pa). Acceptable Gauge and Reinforcement Requirements: Inner duct diameter 4 inches (101 mm) through 11 inches (279 mm) diameter shall be 22 gauge standard pipe (International Mechanical Code).
- C. Ductwork Fittings: Round and have a wall thickness 2 gauges (one even gauge number) heavier than the lightest allowable gauge of the downstream section of duct to which they are connected (International Mechanical Code). Air Duct Branch Entrances: Factory fabricated fittings or factory fabricated duct /tap assemblies. Fittings: Constructed so that air streams converge at angles no greater than 45 degree (International Mechanical Code). All Seams: Continuous stitch welded and if necessary internally sealed to ensure

air tightness. Turning elbows shall be stitch-welded and used for all diameters and pressures. They shall be fabricated of 24 gauge galvanized steel and constructed as two piece with continuous welded seam construction fittings similar to those provided by Lindab Inc. Tapered Body Fittings: Used wherever particular fallout is anticipated and where air flow is introduced to the transport duct manifold.

- D. Ductwork Design Velocities: Minimum of 3500 FPM (18 m/s) to 4000 FPM (20 m/s) transport velocity. Capture Velocity: 4500 FPM (23 m/s) to 5500 FPM (28 m/s) to extract virtually 100 percent of the exhaust gases.
- E. External Ductwork: Sized for the exact inlet and outlet of the exhaust fan blower. An exhaust rain cap shall be supplied and manufactured in accordance with EPA standard for free draft rain cap requirements. Included as an integral part of this rain cap shall be a back draft damper to provide protection from rain and other inclement weather.
- F. Exhaust Penetrations: The core drilling shall be properly sized to reduce the diameter of the opening to the smallest possible size.

## **PART 3 EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Provide surface/substrate preparation as required by the manufacturer's printed installation instructions. Do not proceed with installation is in proper condition to receive vehicle exhaust system installation.

### **3.03 INSTALLATION**

- A. Install vehicle exhaust system in accord with manufacturer's written instructions, original design and referenced standards.

### **3.04 ADJUSTING**

- A. Adjust vehicle exhaust system for proper operation. Replace any parts that prevent the system from operating properly.

### **3.05 CLEANING**

- A. Remove all debris caused by installation of the vehicle exhaust system. Clean all exposed surfaces to as fabricated condition and appearance.

### **3.06 PROTECTION**

- A. Provide protection of the completed installation until completion of the project. Repair any damage at no additional cost to Owner.

### **3.07 TRAINING**

- A. Provide training to fire department personnel in the daily use and maintenance of the vehicle exhaust removal system that has been installed and specified herein. The fire department shall be notified at least 7 days prior to the date scheduled for the training course. Training shall be for all personnel involved with the operation of the exhaust removal system to include all shifts required to man the particular facility. The Training session shall be performed in person by a recognized representative of the manufacturer of the exhaust removal system, in addition a training video shall be provided to the fire department.
  - 1. Provide training to all shifts during their normal shift period.

**3.08 WARRANTY**

- A. Provide a written warranty for a period of one (1) year from date of shipment for all components.

**END OF SECTION 233521**

**SECTION 23 3600****AIR TERMINAL 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:
  - 1. Shutoff, single-duct air terminal units.
- B. Related Sections:
  - 1. Division 1, Section 9601 General Commissioning Requirements+

**1.3 PERFORMANCE REQUIREMENTS****1.4 SUBMITTALS**

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
  - 1. Air terminal units.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
- E. 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.
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

**PART 2 - PRODUCTS****2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Price Industries
  2. Anemostat Products; a Mestek Company.
  3. Carnes.
  4. Environmental Technologies, Inc.
  5. Krueger.
  6. METALAIRE, Inc.
  7. Nailor Industries Inc.
  8. Titus.
  9. Trane; a business of American Standard Companies.
  10. Tuttle & Bailey.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.034-inch (0.85-mm) steel, single wall.
1. Casing Lining: Adhesive attached, 1-inch- (25-mm-) thick, coated, fibrous-glass duct liner complying with ASTM C 1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
    - a. Cover liner with nonporous foil.
    - b. Cover liner with nonporous foil and perforated metal.
  2. Casing Lining: Adhesive attached, 1-inch- (25-mm-) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
  3. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  4. Air Outlet: S-slip and drive connections.
  5. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
  6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
- E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.

- F. Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation and Control for HVAC."

## **2.2 HANGERS AND SUPPORTS**

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. 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.
- C. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

## **2.3 SOURCE QUALITY CONTROL**

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
  - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install terminal units above ceiling so they can be accessed by 8 ft. ladder.

### **3.2 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 and for slabs more than 4 inches (100 mm) thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.

- D. 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.

### **3.3 CONNECTIONS**

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."
- D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

### **3.4 IDENTIFICATION**

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### **3.5 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Refer to Specification Section 019113, General Commissioning Requirements.

**END OF SECTION 23 3600**



**SECTION 23 3713****DIFFUSERS, REGISTERS, AND GRILLES****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:  
  
Diffusers, Registers and Grills.
- B. Related Sections:
  - 1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

**PART 2 - PRODUCTS****2.1 DIFFUSERS, REGISTERS AND GRILLES**

- A. See drawings for requirements
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anemostat Products; a Mestek company.
    - b. Carnes.
    - c. Hart & Cooley Inc.
    - d. METALAIRE, Inc.
    - e. Nailor Industries Inc.
    - f. Price Industries.
    - g. Titus.
    - h. Tuttle & Bailey.

**2.2 SOURCE QUALITY CONTROL**

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

**3.3 ADJUSTING**

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 3713**

**SECTION 23 3813****COMMERCIAL-KITCHEN HOODS****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 Type I commercial kitchen hoods.

**1.3 DEFINITIONS**

- A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.
- B. Standard Hood: A hood, usually field fabricated that complies with design, construction, and performance criteria of applicable national and local codes.
- C. Type I Hood: A hood designed for grease exhaust applications.
- D. Type II Hood: A hood designed for heat and steam removal and for other non-grease applications.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For the following:
  - 1. Standard hoods.
  - 2. Filters/baffles.
  - 3. Fire-suppression systems.
  - 4. Lighting fixtures.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
  - 1. Shop Drawing Scale: 1/4 inch = 1 foot (1:50).
  - 2. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
  - 3. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
  - 4. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
  - 5. Show control cabinets.
  - 6. Show fire-protection cylinders, piping, actuation devices, and manual control devices.

7. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  8. Design Calculations: Calculate requirements for selecting seismic restraints.
  9. Wiring Diagrams: Power, signal, and control wiring.
  10. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.
    - a. Piping Diagram Scale: 1/4 inch = 1 foot (1:50).
- C. Welding certificates.
- D. Manufacturer Seismic Qualification Certification: Submit certification that commercial kitchen hoods, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control test reports.

## **1.5 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.
- 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.

## **1.6 COORDINATION**

- A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

**1.7 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Furnish one complete set(s) of grease filters/baffles.

**PART 2 - PRODUCTS****2.1 HOOD MATERIALS**

- A. Stainless-Steel Sheet: ASTM A 666, Type 304.
1. Minimum Thickness: 0.050 inch (1.3 mm).
  2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
    - a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.
  3. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).
  4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- B. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR, Section 177.2600, for use in areas that come in contact with food.
1. Color: As selected by Architect from manufacturer's full range.
  2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.
- C. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch (3-mm) thickness that does not chip, flake, or blister.
- D. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

**2.2 GENERAL HOOD FABRICATION REQUIREMENTS**

- A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.
1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.

2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
  3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
  4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.
  5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.
- B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."
- C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.
- D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.
- E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.
- F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.
- G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.
- H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.
- I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.
- J. Fabricate seismic restraints according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," Appendix A, "Seismic Restraint Details."
- K. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."
- L. Fabricate enclosure panels to ceiling and wall as follows:
1. Fabricate panels on all exposed side(s) with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.
  2. Wall Offset Spacer: Minimum of 3 inches (75 mm).
  3. Wall Shelves and Overshelves: Fabricate according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," with minimum 0.0625-inch- (1.58-mm-) thick, stainless-steel shelf tops.

## **2.3 TYPE I EXHAUST HOOD FABRICATION**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CaptiveAire.

2. Greenheck.
  3. Halton Company.
- B. Weld all joints exposed to grease with continuous welds, and make filters/baffles or grease extractors and makeup air diffusers easily accessible for cleaning.
1. Fabricate hoods according to NSF 2, "Food Equipment."
  2. Hoods shall be listed and labeled, according to UL 710, by a testing agency acceptable to authorities having jurisdiction.
  3. Hoods shall be designed, fabricated, and installed according to NFPA 96.
  4. Include access panels as required for access to fire dampers and fusible links.
  5. Duct Collars: Minimum 0.0598-inch- (1.5-mm-) thick steel at least 3 inches (75 mm) long, continuously welded to top of hood and at corners. Fabricate a collar with a 0.5-inch- (13-mm-) wide duct flange.
  6. Duct-Collar Fire Dampers: Collar and damper shall comply with UL 710 testing and listing required for the entire hood.
    - a. Collar: Minimum 0.0598-inch- (1.5-mm-) thick stainless steel, at least 3 inches (75 mm) long, continuously welded to top of hood and at corners. Fabricate a collar with a minimum 0.5-inch- (13-mm-) wide duct flange.
    - b. Blades: Minimum 0.1046-inch- (2.7-mm-) thick stainless steel, counterbalanced to remain closed after actuation.
    - c. Blade Pivot and Spring: Stainless steel.
    - d. Fusible Link: Replaceable, 212 deg F (100 deg C) rated.
- C. Hood Configuration: Exhaust and makeup air.
1. Makeup air shall be introduced through front of canopy through perforated diffusers.
  2. Makeup air shall be introduced through laminar-flow-type, perforated metal panels on front of hood canopy.
- D. Hood Style: Wall . mounted canopy.
- E. Filters/Baffles: Removable, stainless-steel. Fabricate stainless steel for filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Filters/baffles shall be tested according to UL 1046, "Grease Filters for Exhaust Ducts," by an NRTL acceptable to authorities having jurisdiction.
- F. Lighting Fixtures: Surface-mounted, fluorescent fixtures and lamps with lenses sealed vaportight. Wiring shall be installed in conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc (753 lx) at 30 inches (762 mm) above finished floor.
1. Light switches shall be mounted in hood control panel.
  2. Lighting Fixtures: Fluorescent complying with UL 1598.
- G. Hood Controls: Wall-mounting control cabinet,fabricated of stainless steel.
1. Exhaust Fan: On-off switches shall start and stop the exhaust fan. Interlock exhaust fan with makeup air supply fan to operate simultaneously. Interlock exhaust fan with fire-suppression system to operate fan(s) during fire-suppression-agent release and to remain in operation until manually stopped. Include red pilot light to indicate fan operation. Motor starters shall comply with Section 262913 "Enclosed Controllers."
  2. High-Temperature Control: Alarm shall sound and cooking equipment shall shut down before hood discharge temperature rises to actuation temperature of fire-suppression system.

## 2.4 WET-CHEMICAL FIRE-SUPPRESSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ansul Incorporated; a Tyco International Ltd. Company.
  2. Kidde Fire Systems.
  3. Pyro Chem.
- B. Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.
1. Steel Pipe, NPS 2 (DN 50) and Smaller: ASTM A 53/A 53M, Type S, Grade A, Schedule 40, plain ends.
  2. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
  3. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on wall. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.
  4. Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.
  5. Furnish electric-operated gas shutoff valve; refer to Section 231123 "Facility Natural-Gas Piping."
  6. Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.
  7. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm, and wiring to start fan with fire alarm.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Complete field assembly of hoods where required.
1. Make closed butt and contact joints that do not require filler.
  2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication Requirements" Article.



- B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.
- C. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.
- D. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.
- E. Install hoods to operate free from vibration.
- F. Install seismic restraints according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines," Appendix A, "Seismic Restraint Details."
- G. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches (1200 mm) o.c. maximum.
- H. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.
- I. Install lamps, with maximum recommended wattage, in equipment with integral lighting.
- J. Set initial temperatures, and calibrate sensors.
- K. Set field-adjustable switches.

### **3.3 CONNECTIONS**

- A. Install piping with clearance to allow service and maintenance.
- B. Connect ducts according to requirements in Section 233300 "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquid tight joint.
- C. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

### **3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. 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.
- C. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

## D. Tests and Inspections:

1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
4. Perform hood performance tests required by authorities having jurisdiction.
5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

## E. Prepare test and inspection reports.

**3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods. Refer to Section 017900 "Demonstration and Training."

**END OF SECTION 23 3813**

**SECTION 23 5100****BREECHINGS, CHIMNEYS, AND STACKS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Listed double-wall vents.

**1.3 SUBMITTALS**

- A. Welding certificates.
- B. Warranty: Special warranty specified in this Section.

**1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain listed system components through one source from a single manufacturer.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.
- C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

**1.5 COORDINATION**

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

**1.6 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
  - 1. Warranty Period: 15 years from date of Substantial Completion.

**PART 2 - PRODUCTS****2.1 LISTED TYPE L VENTS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Selkirk Metalbestos IPSC1 or a comparable product by one of the following:
1. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
  2. American Metal Products; MASCO Corporation.
  3. Heat-Fab, Inc.
  4. Metal-Fab, Inc.
- B. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F (300 deg C) continuously, or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 1-inch (25-mm) airspace filled with high-temperature, mineral-wool insulation.
- D. Inner Shell: ASTM A 666, Type 304 stainless steel.
- E. Outer Jacket: Stainless steel.
- F. Accessories: Draft diverter, connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
1. Termination: Stack cap designed to exclude 90 percent of rainfall.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION OF LISTED VENTS AND CHIMNEYS**

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- C. Lap joints in direction of flow.
- D. Install vent and vent accessories in accordance with equipment manufacturer's recommendations.

**3.3 CLEANING**

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

**END OF SECTION 23 5100**



**SECTION 23 5216**  
**CONDENSING BOILERS**

**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 packaged, factory-fabricated and -assembled, gas-fired, fire-tube and water-jacketed condensing boilers, trim, and accessories for generating hot water.
- B. Related Sections:
  - 1. Division 1, Section 96 General Commissioning Requirements+

**1.3 SUBMITTALS**

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: Power, signal, and control wiring
- C. Source quality-control test reports.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.
- G. Other Informational Submittals:
  - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

**1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- F. 1=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified AHRI as capable of achieving the energy efficiency and performance ratings as tested with prescribed tolerances.

## **1.5 COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## **1.6 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Fire-Tube Condensing Boilers:
    - a. Leakage and Materials: 10 years from date of Substantial Completion.
    - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for ten years from date of Substantial Completion.
  - 2. Warranty Period for Water-Jacketed Condensing Boilers:
    - a. Leakage and Materials: Eight years from date of Substantial Completion.
    - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five 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. Lochinvar Corporation.
  - 2. Viessmann Manufacturing Co. (US) Inc.
  - 3. AERCO International.



**2.2 MANUFACTURED UNITS**

- A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- B. Heat Exchanger: 316L stainless steel, 160 PSIG working pressure.
- C. Pressure Vessel: Carbon steel with welded heads and tube connections.
- D. Burner: Natural gas, forced draft. All burner materials exposed to combustion shall be stainless steel. The burner shall be capable of 20:1 turn down.
- E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
  - 1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
    - a. 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.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- H. Casing:
  - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
  - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
  - 3. Finish: Baked-enamel protective finish.
  - 4. Insulation: Minimum 2-inch- (50-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.
  - 5. Combustion-Air Connections: Inlet and vent duct collars.
  - 6. Mounting base to secure boiler.

**2.3 MANUFACTURED UNITS**

- A. Description: Factory-fabricated, -assembled, and -tested, water-jacketed condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; water supply, return, and condensate drain connections; and controls. Water heating service only.
- B. Heat Exchanger: Stainless-steel primary and secondary combustion chamber.
- C. Pressure Vessel: Carbon steel with welded heads and tube connections where not in contact with combustion or flue gases.
- D. Burner: Natural gas, forced draft; swing-open front and burner observation port.
- E. Blower: Centrifugal fan, forced draft. Include prepurge and postpurge of the combustion chamber.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - a. 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.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.
- G. Ignition: Electric-spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- H. Casing:
  1. Jacket: Sheet metal, with snap-in or interlocking closures.
  2. Control Compartment Enclosures: NEMA 250, Type 1A.
  3. Finish: Powder-coated protective finish.
  4. Insulation: Minimum 4-inch- (100-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.
  5. Combustion-Air Connections: Inlet and vent duct collars.

## 2.4 TRIM

- A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
- B. Aquastat Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Boiler Air Vent: Manual.
- E. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.

## 2.5 CONTROLS

- A. Refer to Division 23 Section "Instrumentation and Control for HVAC."
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
  1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
  2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
  3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
  4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- C. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
  1. Hardwired Points:

- a. Monitoring: On/off status, common trouble alarm.
  - b. Control: On/off operation, hot water supply temperature set-point adjustment.
2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

## **2.6 ELECTRICAL POWER**

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
  1. House in NEMA 250, Type 1 enclosure.
  2. Wiring shall be numbered and color-coded to match wiring diagram.
  3. Field power interface shall be to nonfused disconnect switch.
  4. Provide each motor with overcurrent protection.

## **2.7 VENTING KITS**

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel or, where recommended by the manufacturer, PCV, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, PVC pipe, vent terminal with screen, inlet air coupling, and sealant.

## **2.8 SOURCE QUALITY CONTROL**

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Refer to Specification Section 019113, General Commissioning Requirements.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 BOILER INSTALLATION**

- A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Vibration Isolation: Elastomeric isolation pads with a minimum static deflection of 0.25 inch (6.35 mm). Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install gas-fired boilers according to NFPA 54.
- D. Assemble and install boiler trim.
- E. Install electrical devices furnished with boiler but not specified to be factory mounted.
- F. Install control wiring to field-mounted electrical devices. Boiler manufacturer shall be responsible for wiring between the boilers and the boiler control panels.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC,"
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Boiler Venting:
  1. Install flue venting kit and combustion-air intake.

- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### **3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports: Refer to Specification Section 019113, General Commissioning Requirements.
- B. 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.

### **3.5 DEMONSTRATION**

- A. Refer to Specification Section 019113, General Commissioning Requirements.

**END OF SECTION 23 5216**



**SECTION 23 5523****GAS-FIRED RADIANT HEATERS****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 gas-fired, tubular infrared radiant heaters.
- B. Related Sections:
  - 1. Division 1, Section 960 General Commissioning Requirements+

**1.3 SUBMITTALS**

- A. Product Data: For each type of gas-fired radiant heater indicated. Include rated capacities, operating characteristics, and accessories.
- B. Coordination Drawings: Plans, elevations, 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 equipment will be attached.
  - 2. Items penetrating roof and the following:
  - 3. Radiant Heater Layout
    - a. Vent and gas piping rough-ins and connections.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For gas-fired radiant heaters to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

**1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

**1.5 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of gas-fired radiant heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

**1.6 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Burner Igniters: One hot-surface burner igniters for each style of gas-fired radiant heater furnished.

**PART 2 - PRODUCTS****2.1 TUBULAR INFRARED HEATERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Gas-Fired Products Inc.; Space-Ray Div.
  2. Reznor/Thomas & Betts Corporation.
  3. Roberts-Gordon, Inc.
  4. Solaronics, Inc.
  5. Sterling HVAC Products; Div. of Mestek Technology Inc.
- C. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.20/CSA 2.34.
- D. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.
- E. Combustion Tubing: 4-inch- (100-mm-) diameter aluminized steel with high-emissivity, high-temperature, corrosion-resistant external finish.
- F. Tubing Connections: Stainless-steel couplings or flared joints with stainless-steel draw bolts.
- G. Reflector: Polished aluminum, 97 percent minimum reflectivity, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Provide for rotating reflector or heater around a horizontal axis for minimum 30-degree (0.52-radian) tilt from vertical.
1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees (0.52 radians) from vertical.
  2. Include hanger kit.
- H. Burner Safety Controls:



1. Gas Control Valve: Single-stage, regulated redundant 24-V ac gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
  2. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.
  3. Control Panel Interlock: Stops burner if panel is open.
  4. Indicator Lights: Burner-on indicator light.
- I. Burner and Emitter Type: Gravity-vented power burner, with the following features:
1. Emitter Tube: 4-inch- (100-mm-) diameter, aluminized-steel tubing with sight glass for burner and pilot flame observation.
  2. Venting: Concentric vent for combustion air and flue gas with rain cap for both.
    - a. Vent Terminal: Vertical.
  3. Burner/Ignition: Power gas burner with electronic spark and electronic flame safety.
  4. Burner/Ignition: Stainless-steel burner cup and head with balanced-rotor draft fan and spark ignition with electronic flame supervision.
  5. Combustion-Air Connection: Duct connection for combustion air to be drawn directly from outdoors by burner fan.
- J. Burner and Emitter Type: Vacuum-vented burner, with the following features:
1. Emitter Tube: 4-inch- (100-mm-) diameter, aluminized-steel tubing with sight glass for burner and pilot flame observation.
  2. Burner/Ignition: Electronic spark and electronic flame safety.
    - a. Venting: Burner exhaust tubing connected at exit end to vacuum-fan inlet.
    - b. Venting: Balancing damper at exit end of burner exhaust tubing and at connection to manifold tube.
  3. Vacuum Fan: Dynamically balanced, direct-driven, cast-aluminum-alloy impeller in an aluminized-steel housing, isolated from system by flexible connector with a minimum temperature rating of 450 deg F (232 deg C).
    - a. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      - 1) Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.
      - 2) 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.
      - 3) Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
  4. Balancing Dampers: Plate type, mounted in cast, double-flange fitting with vacuum test plug.
  5. Filter: Cartridge type for mounting on burner housing.
  6. Combustion-Air Connection: Duct connection to burner for combustion air to be drawn directly from outside.
  7. Outdoor-Air Connection: Dynamically balanced, direct-driven, forward-curved fan with duct connection to each burner.

- a. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1) Motor: Resilient-mounted, capacitor-start-capacitor-run type, thermally protected with sealed ball bearings.
  - 2) 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.
  - 3) Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

## **2.2 CONTROLS**

- A. Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.
  1. Control Transformer: Integrally mounted.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install and connect gas-fired radiant heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.
- B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments.
- C. Maintain manufacturers' recommended clearances to combustibles.

### **3.2 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to gas-fired radiant heaters to allow service and maintenance.
- C. Gas Piping: Comply with Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
- D. Vent Connections: Comply with Division 23 Section "Breechings, Chimneys, and Stacks."
- E. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
  1. Install electrical devices furnished with heaters but not specified to be factory mounted.

### **3.3 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Refer to Specification Section 019113, General Commissioning Requirements.

**3.4 ADJUSTING**

- A. Adjust initial temperature set points.
- B. Adjust burner and other unit components for optimum heating performance and efficiency.

**3.5 DEMONSTRATION**

- A. Refer to Specification Section 019113, General Commissioning Requirements.

**END OF SECTION 23 5523**



**SECTION 23 6423****SCROLL WATER CHILLERS****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. Packaged, air-cooled, electric-motor-driven, scroll water chiller.

**1.3 DEFINITIONS**

- A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
- D. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.

**1.4 SUBMITTALS**

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
  - 1. Performance at ARI standard conditions and at conditions indicated.
  - 2. Performance at ARI standard unloading conditions.
  - 3. Minimum evaporator flow rate.
  - 4. Refrigerant capacity of water chiller.
  - 5. Oil capacity of water chiller.
  - 6. Fluid capacity of evaporator.
  - 7. Characteristics of safety relief valves.
  - 8. Minimum entering condenser-air temperature
  - 9. Performance at varying capacity with constant design entering condenser-air temperature.

- B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
  - 1. Assembled unit dimensions.
  - 2. Weight and load distribution.
  - 3. Required clearances for maintenance and operation.
  - 4. Size and location of piping and wiring connections.
  - 5. Wiring Diagrams: For power, signal, and control wiring.
  - 6. and their installation requirements.
- C. Source quality-control test reports.
- D. Startup service reports.
- E. Operation and Maintenance Data: For water chiller to include in emergency, operation, and maintenance manuals.
- F. Warranty: Sample of special warranty.

### **1.5 QUALITY ASSURANCE**

- A. ARI Certification: Certify chiller according to ARI 590 certification program.
- B. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
- D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- F. Comply with NFPA 70.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

### **1.7 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

### **1.8 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified period.
  - 1. Compressor Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS****2.1 PACKAGED AIR-COOLED WATER CHILLER**

- A. Manufacturers: Subject to compliance with requirements, Provide products by manufacturers specified.
1. Daikin
  2. Carrier
  3. Trane
- B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.
- C. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.
- D. Cabinet:
1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
  2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
  3. Casing: Galvanized steel.
  4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
- E. Compressors:
1. Description: Positive-displacement direct drive with hermetically sealed casing.
  2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
  3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
  4. Capacity Control: On-off compressor cycling, plus hot-gas bypass.
  5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
  6. Vibration Isolation: Mount individual compressors on vibration isolators.
- F. Compressor Motors:
1. Hermetically sealed and cooled by refrigerant suction gas.
  2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- G. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
- H. Refrigeration:
1. Refrigerant: . Classified as Safety Group A1 according to ASHRAE 34.
  2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

I. Evaporator:

1. Brazed-plate or shell-and-tube design, as indicated.
2. Shell and Tube:
  - a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
  - b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
  - c. Shell Material: Carbon steel.
  - d. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.
  - e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
  - f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
3. Brazed Plate:
  - a. Direct-expansion, single-pass, brazed-plate design.
  - b. Type 316 stainless-steel construction.
  - c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
  - d. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
4. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F (minus 29 deg C).
5. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

J. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig (3103 kPa).
  - a. Construct coils of copper tubes mechanically bonded to aluminum fins.
  - b. Coat coils with a baked epoxy corrosion-resistant coating after fabrication.
  - c. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.



## K. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
  - a. 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.
  - b. NEMA KS 1, heavy-duty, nonfusible switch.
  - c. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
9. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
10. Provide power factor correction capacitors to correct power factor to 0.90 at full load.
11. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
  - a. Power unit-mounted controls where indicated.
  - b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.
12. Control Relays: Auxiliary and adjustable time-delay relays.
13. Indicate the following for water chiller electrical power supply:
  - a. Current, phase to phase, for all three phases.
  - b. Voltage, phase to phase and phase to neutral for all three phases.
  - c. Three-phase real power (kilowatts).
  - d. Three-phase reactive power (kilovolt amperes reactive).
  - e. Power factor.
  - f. Running log of total power versus time (kilowatt hours).
  - g. Fault log, with time and date of each.

## L. Controls:

1. Stand-alone, microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
  - a. Date and time.
  - b. Operating or alarm status.
  - c. Operating hours.
  - d. Outside-air temperature if required for chilled-water reset.
  - e. Temperature and pressure of operating set points.
  - f. Entering and leaving temperatures of chilled water.

- g. Refrigerant pressures in evaporator and condenser.
  - h. Saturation temperature in evaporator and condenser.
  - i. No cooling load condition.
  - j. Elapsed time meter (compressor run status).
  - k. Pump status.
  - l. Antirecycling timer status.
  - m. Percent of maximum motor amperage.
  - n. Current-limit set point.
  - o. Number of compressor starts.
4. Control Functions:
- a. Manual or automatic startup and shutdown time schedule.
  - b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.
  - c. Current limit and demand limit.
  - d. External water chiller emergency stop.
  - e. Antirecycling timer.
  - f. Automatic lead-lag switching.
5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
- a. Low evaporator pressure or high condenser pressure.
  - b. Low chilled-water temperature.
  - c. Refrigerant high pressure.
  - d. High or low oil pressure.
  - e. High oil temperature.
  - f. Loss of chilled-water flow.
  - g. Control device failure.
- M. Insulation:
- 1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
  - 2. Thickness: 3/4 inch (19 mm).
  - 3. Factory-applied insulation over cold surfaces of water chiller components.
    - a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
  - 4. Apply protective coating to exposed surfaces of insulation.
- N. Accessories:
- 1. Factory-furnished, chilled-water flow switches for field installation.
  - 2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
  - 3. Factory-furnished neoprene or spring isolators for field installation.
- O. Capacities and Characteristics:
- 1. For capacities refer to drawings.

**2.2 SOURCE QUALITY CONTROL**

- A. Perform functional test of water chiller before shipping.
- B. Factory performance test water chiller, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- D. Rate sound power level according to ARI 370 procedure. Confirm that the sound power level does not exceed 80.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
  - 1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 WATER CHILLER INSTALLATION**

- A. Install water chillers on support structure indicated.
- B. Maintain manufacturer's recommended clearances for service and maintenance.
- C. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- D. Install separate devices furnished by manufacturer and not factory installed.

**3.3 CONNECTIONS**

- A. Comply with requirements in Division 23 Section "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve. Make connections to water chiller with a flange.

**3.4 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
  - 2. Verify that pumps are installed and functional.
  - 3. Verify that thermometers and gages are installed.
  - 4. Operate water chiller for run-in period.
  - 5. Check bearing lubrication and oil levels.
  - 6. Verify proper motor rotation.
  - 7. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
  - 8. Verify and record performance of chilled-water flow and low-temperature interlocks.
  - 9. Verify and record performance of water chiller protection devices.
  - 10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.

**3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

**END OF SECTION 23 6423**

**SECTION 23 7313****MODULAR INDOOR CENTRAL-STATION AIR-HANDLING 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:
  - 1. Variable-Air Volume air-handling units.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of  $L/200$  where "L" is the unsupported span length within completed casings.

**1.4 SUBMITTALS**

- A. Product Data: For each air-handling unit indicated.
  - 1. Unit dimensions and weight.
  - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
  - 3. Fans:
    - a. Certified fan-performance curves with system operating conditions indicated.
    - b. Certified fan-sound power ratings.
    - c. Fan construction and accessories.
    - d. Motor ratings, electrical characteristics, and motor accessories.
  - 4. Certified coil-performance ratings with system operating conditions indicated.
  - 5. Dampers, including housings, linkages, and operators.
  - 6. Filters with performance characteristics.
- B. Delegated-Design Submittal: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
  2. Support location, type, and weight.
  3. Field measurements.
- D. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

### **1.5 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

### **1.6 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, with actual equipment provided.

### **1.7 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Filters: One set for each air-handling unit.
  2. Gaskets: One set for each access door.
  3. Fan Belts: One set for each air-handling unit fan.

**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:
1. Daikin International
  2. Trane; American Standard Inc.
  3. Carrier Corporation; a member of the United Technologies Corporation Family.

**2.2 UNIT CASINGS**

- A. General Fabrication Requirements for Casings:
1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
  2. Casing Joints: Sheet metal screws or pop rivets.
  3. Sealing: Seal all joints with water-resistant sealant.
  4. Factory Finish for Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
  5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- B. Casing Insulation and Adhesive:
1. Materials: ASTM C 1071, Type I.
  2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
    - a. Liner Adhesive: Comply with ASTM C 916, Type I.
    - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
  3. Location and Application: Minimum 2+ thick and 3# density encased between outside and inside casing.
- C. Inspection and Access Panels and Access Doors:
1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
  2. Inspection and Access Panels:
    - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
    - b. Gasket: Neoprene, applied around entire perimeters of panel frames.

- c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
- 3. Access Doors:
  - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from outside. Arrange doors to be opened against air-pressure differential.
  - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
  - c. seals.
  - d. Size: At least 18 inches (450 mm) wide by full height of unit casing up to a maximum height of 60 inches (1500 mm).
- 4. Locations and Applications:
  - a. Fan Section: Doors.
  - b. Access Section: Doors.
  - c. Coil Section: Inspection and access panel.
  - d. Damper Section: Inspection and access panels.
  - e. Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
  - f. Mixing Section: Doors.
- D. Condensate Drain Pans:
  - 1. 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 to direct water toward drain connection.
    - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-2004.
    - b. Depth: A minimum of 2 inches (50 mm) deep.
  - 2. Formed sections.
  - 3. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
  - 4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
    - a. Minimum Connection Size: NPS 1 (DN 25).
  - 5. Pan-Top Surface Coating: Asphaltic waterproofing compound.
  - 6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

## **2.3 FAN, DRIVE, AND MOTOR SECTION**

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
  - 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.



- a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
  - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- B. Plenum Fan Wheels: Constructed with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- C. Fan Shaft Bearings:
  1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 50,000 hours according to ABMA 9.
  2. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit and a rated life of 50,000 hours according to ABMA 11.
- D. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
  1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 Insert number hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
  3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
  4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch- (2.7-mm-) thick, 3/4-inch (20-mm) diamond-mesh wire screen, welded to steel angle frame; prime coated.
- E. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  1. Enclosure Type: Totally enclosed, fan cooled.
  2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  3. 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.
  4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

## **2.4 COIL SECTION**

- A. General Requirements for Coil Section:
  1. Comply with ARI 410.
  2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
  3. Coils shall not act as structural component of unit.

## **2.5 AIR FILTRATION SECTION**

- A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.

## 2.7 FILTER SECTION

### A. General Requirements for Air Filtration Section:

2. Comply with NFPA 90A.
3. Filters having a Minimum Efficiency Reporting Value (MERV) as determined by ASHRAE 52.2-1999
  - a. MERV-13.

### B. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.

### C. Extended-Surface, Nonsupported-Media Filters: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames.

4. Media: Fibrous material so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.
5. Filter-Media Frame: Galvanized steel.
6. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

## 2.6 DAMPERS

### A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm (10-m/s) face velocity through damper and 4-inch wg (1000-Pa) pressure differential.

### B. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

### C. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC."
  - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
  - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for 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).
5. 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).

6. Size dampers for running torque calculated as follows:
  - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
  - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
  - c. 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.
  - d. 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.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
11. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
12. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
13. Insulate exterior with duct insulation and mount on 2-inch (-(50-mm-)) thick, rigid insulation board.

## 2.8 SOURCE QUALITY CONTROL

- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- C. Water Coils: Factory tested to 300 psig (2070 kPa) according to ARI 410 and ASHRAE 33.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Equipment Mounting: Install air-handling units on concrete bases using restrained spring isolators. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
  - 1. Minimum Deflection: 1 inch (25 mm).
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  - 3. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install final filters after the unit housing have been internally cleaned of all construction debris.
- E. Provide pressure gauge at the final filter to measure the pressure drop across the filters.

### 3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4 (DN 32), ASTM B 88, Type M (ASTM B 88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- F. Piping." Install shutoff valve and union or flange at each supply and return connection.
- G. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories."

**3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
  - 1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
  - 2. Fan 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.
- C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

**3.5 STARTUP SERVICE**

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Verify that shipping, blocking, and bracing are removed.
  - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
  - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
  - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
  - 6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
  - 7. Comb coil fins for parallel orientation.
  - 8. Verify that proper thermal-overload protection is installed for electric coils.
  - 9. Install new, clean filters.
  - 10. Verify that manual and automatic volume control and fire dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
  - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
  - 2. Measure and record motor electrical values for voltage and amperage.
  - 3. Manually operate dampers from fully closed to fully open position and record fan performance.
  - 4. Confirm the proper operation of the variable frequency drive.

**3.6 ADJUSTING**

- C. Adjust damper linkages for proper damper operation.
- D. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

**3.6 CLEANING**

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

**3.7 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

**END OF SECTION 23 7313**

**SECTION 23 7339****OUTDOOR, DIRECT GAS-FIRED HEATING AND VENTILATING 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. This Section includes direct-fired H&V units.
- B. Related Sections:
  - 1. Division 1, Section 960 General Commissioning Requirements+

**1.3 SUBMITTALS**

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. LEED Submittal:
  - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."
- C. 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. Prepare the following by or under the supervision of a qualified professional engineer:
  - 1. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
  - 3. Wiring Diagrams: Power, signal, and control wiring.
- D. Coordination Drawings: Roof-mounted units and roof-curb mounting 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. Size and location of rooftop unit mounting rails and anchor points and methods for anchoring units to curb.
  - 2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.
- E. Startup service reports.

- F. Operation and Maintenance Data: For direct-fired H&V units to include in emergency, operation, and maintenance manuals.

#### **1.4 QUALITY ASSURANCE**

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of direct-fired H&V units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

#### **1.5 COORDINATION**

- A. Coordinate size, location, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- B. Coordinate size, location and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

#### **1.6 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One sets for each unit.
  - 2. Fan Belts: One sets for each unit.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Trane
  - 2. Cambridge Engineering, Inc.
  - 3. Captive-Air Systems, Inc.
  - 4. CES Group; Ventrol Air Handling Systems, Inc.
  - 5. Des Champs Laboratories Incorporated; a unit of Entrodyne Corporation.
  - 6. Engineered Air.
  - 7. Greenheck



8. Hastings Industries; Division of Erie, Inc.
9. Modine Mfg. Co.; Commercial HVAC&R Division.
10. Rapid Engineering, Inc.
11. Reznor-Thomas & Betts Corporation; Mechanical Products Division.
12. Sterling Gas; Mestek, Inc.

## **2.2 PACKAGED UNITS**

- A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters and direct-fired gas furnace to be installed outside the building.

## **2.3 CABINET**

- A. Cabinet: Double . wall galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Cabinet shall be fully weatherized for outside installation.
- B. Access Panels: Piano hinged with cam-lock fasteners for furnace and fan motor assemblies on both sides of unit.
- C. Insulation: Fibrous-glass, comply with ASTM C 1071, Type II, applied on complete unit.
  1. Thickness: 1 inch (25 mm).
- D. Finish: Heat-resistant, baked enamel.
- E. Discharge: Horizontal pattern, galvanized-steel assembly with diffusers incorporating individually adjustable vanes.
- F. Roof Curb: Full-perimeter curb of sheet metal, minimum 16 inches (400 mm) high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

## **2.4 SUPPLY-AIR FAN**

- A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty pillow-block bearings rated for L50 or 200,000 hours with external grease fittings.
- B. Motor: Single speed motor.
- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.
- D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.

## **2.5 OUTDOOR-AIR INTAKE**

- A. Outdoor-Air Hood: Galvanized steel with rain baffles, bird screen complying with ASHRAE62.1-2004 and finish to match cabinet; and sized to supply maximum 100 percent outdoor air.

## **2.6 AIR FILTERS**

- A. Comply with NFPA 90A.
- B. Provide v-bank filter rack.

- C. Disposable Panel Filters: 2-inch (50 mm) thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames with a minimum efficiency report value of 13 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.
  - 1. Media: Interlaced glass fibers.
  - 2. Frame: Galvanized steel.

## 2.7 DAMPERS

- A. Outside air Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. (51 L/s per sq. m) of damper area, at differential pressure of 2-inch wg (448 Pa).
- B. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.

## 2.8 DIRECT-FIRED GAS FURNACE

- A. Description: Factory assembled, piped, and wired; and complying with ANSI Z83.4, ~~%Direct Gas-Fired Make-Up Air Heaters+~~; ANSI Z83.18, ~~%Direct Gas-Fired Industrial Air Heaters+~~; and NFPA 54, ~~%National Fuel Gas Code+~~.
- B. Inside Unit External Housing: Steel cabinet with integral support inserts.
- C. Outside Unit External Housing: Weatherproof steel cabinet with integral support inserts.
  - 1.External Casing and Cabinet Finish: Baked enamel over corrosion resistance-treated surface in color to match fan section.
- D. Burners: Cast-iron burner with stainless-steel mixing plates.
  - 1. Control Valve: Modulating with minimum turndown ratio of 25:1.
  - 2. Fuel: Natural gas.
  - 3. Pilot: Electrically ignited by hot-surface ceramic igniter.
- E. Safety Controls:
  - 1. Gas Manifold: Safety switches and controls to comply with ANSI standards and IRI.
  - 2. Purge-Period Timer: Automatically delays burner ignition and bypasses low-limit control.
  - 3. Airflow Proving Switch: Dual pressure switch senses correct airflow before energizing pilot and requires airflow to be maintained within minimum and maximum pressure settings across burner.
  - 4. Manual-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
  - 5. Gas Train: Redundant, automatic main gas valves, electric pilot valve, electronic modulating temperature control valve, main and pilot gas regulators, main and pilot manual shutoff valves, main and pilot pressure taps, and high-low gas pressure switches to comply with IRI requirements.
  - 6. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
  - 7. Control Transformer: Integrally mounted 24-V ac.

**2.9 CONTROLS**

- A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
- B. Control Panel: Remote panel, with engraved plastic cover, and the following lights and switches.
  - 1. On-Off auto switch.
  - 2. Summer-winter switch.
  - 3. Supply-fan operation indicating light.
  - 4. Heating operation indicating light.
  - 5. Damper position potentiometer.
  - 6. Thermostat.
  - 7. Cooling operation indicating light.
  - 8. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
  - 9. Safety-lockout indicating light.
- C. Fan Control: Interlock fan to start with exhaust fans. See drawings for exhaust fan controls.
- D. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
- E. DDC: Stand-alone control module for link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Division 23 Section 23-06 Instrumentation and Control for HVAC.
  - 1. Provide start and stop interface relay, and relay to notify DDC system alarm condition.
  - 2. Provide hardware interface or additional sensors as follows:
    - a. Room temperature.
    - b. Discharge-air temperature.
    - c. Furnace operating.

**2.10 MOTORS**

- A. Comply with requirements in Division 23 Section 23-09 Common Motor Requirements for HVAC equipment.

**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 installation of direct-fired H&V units.
- 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 rooftop replacement-air units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."
- B. Install roof curb on roof structure, according to ARI Guideline. Install and secure direct-fired H&V units on curbs, and coordinate roof penetrations and flashing with roof construction.
- C. Install controls and equipment shipped by manufacturer for field installation with direct-fired H&V units.

### **3.3 CONNECTIONS**

- A. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
  - 1. Gas Piping: Comply with requirements in Division 23 Section "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors.
- B. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to direct-fired H&V units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### **3.4 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Inspect for visible damage to furnace combustion chamber.
  - 2. Inspect casing insulation for integrity, moisture content, and adhesion.
  - 3. Verify that clearances have been provided for servicing.
  - 4. Verify that controls are connected and operable.
  - 5. Verify that filters are installed.
  - 6. Purge gas line.
  - 7. Inspect and adjust vibration isolators.
  - 8. Verify bearing lubrication.
  - 9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  - 10. Adjust fan belts to proper alignment and tension.

11. Start unit according to manufacturer's written instructions.
  12. Complete startup sheets and attach copy with Contractor's startup report.
  13. Inspect and record performance of interlocks and protective devices; verify sequences.
  14. Operate unit for run-in period recommended by manufacturer.
  15. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
    - a. Measure gas pressure on manifold.
    - b. Measure combustion-air temperature at inlet to combustion chamber.
    - c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
  16. Calibrate thermostats.
  17. Adjust and inspect high-temperature limits.
  18. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
  19. Start evaporative cooler system and measure and record the following:
    - a. Leaving-air, dry- and wet-bulb temperatures.
    - b. Entering-air, dry- and wet-bulb temperatures.
  20. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
  21. Measure and record airflow. Plot fan volumes on fan curve.
  22. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.
- D. Prepare written report of the results of startup services.

### **3.5 ADJUSTING**

- A. Adjust initial temperature 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. Refer to Specification Section 019113, General Commissioning Requirements.

**END OF SECTION 23 7339**



**SECTION 23 7414****PACKAGED, CONSTANT AIR VOLUME ROOFTOP AIR HANDLING 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. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
  - 1. Direct-expansion cooling.
  - 2. Gas furnace.
  - 3. Economizer outdoor- and return-air damper section.
  - 4. Roof curbs.
  - 5. Manufacturer's DDC Control Panel.
- B. Related Sections:
  - 1. Division 1, Section 9.0 General Commissioning Requirements+

**1.3 DEFINITIONS**

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.

**1.4 SUBMITTALS**

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. LEED Submittals:
  - 1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
  - 2. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.

- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.

## **1.5 QUALITY ASSURANCE**

- A. ARI Compliance:
  - 1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
  - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
  - 1. Comply with ASHRAE 15 for refrigeration system safety.
  - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
  - 3. Comply with applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

## **1.6 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for unit: One year parts and service from date of Substantial Completion.
  - 2. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 3. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
  - 4. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
  - 5. Warranty period for control boards: Manufacturer's standard but not less than three years from date of substantial completion.

## **1.7 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.



1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daikin (basis of design)
  2. Carrier Corporation.
  3. Trane

### **2.2 GENERAL**

- A. Units(s) shall be single piece construction as manufactured at the factory. (Site assembled sub-assemblies will not be allowed). Package units shall be constructed for installation on a roof curb providing full perimeter support under air handler section and pedestal support under condenser section.

### **2.3 CASING**

- A. General Fabrication Requirements for Casings: Formed and reinforced 1 inch double-wall insulated panels on all surfaces exposed to air stream, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
1. Exterior Casing Thickness: 0.0626 inch (1.6 mm) thick.
- C. Inner Casing Fabrication Requirements:
2. Inside Casing: Galvanized steel, 0.034 inch (0.86 mm) thick.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1. Materials: Fiberglass minimum 3 Lb. density.
  2. Thickness: 1 inch.
- E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1-2004.
1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
  2. Drain Connections: Threaded nipple both sides of drain pan.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

- G. Access doors: Fully gasketed hinged doors with fluted knob fasteners and chained tie-backs to provide access to filters, heating section, return/exhaust air fan section, supply air fan section and evaporator coil section.

## 2.4 FANS

- A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- C. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

## 2.5 COILS

- A. Supply-Air Refrigerant Coil:
  - 1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
  - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
  - 3. Coil Split: Interlaced.
  - 4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1-2004.

## 2.6 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: Minimum 2 circuits for units over 10 tons.
- B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
- C. Refrigeration Specialties:
  - 1. Refrigerant: R-410A.
  - 2. Expansion valve with replaceable thermostatic element.
  - 3. Refrigerant filter/dryer.
  - 4. Manual-reset high-pressure safety switch.
  - 5. Automatic-reset low-pressure safety switch.
  - 6. Minimum off-time relay.
  - 7. Automatic-reset compressor motor thermal overload.
  - 8. Brass service valves installed in compressor suction and liquid lines.
  - 9. Low-ambient kit high-pressure sensor.

**2.7 AIR FILTRATION**

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  - 1. Pleated: Filters shall be 2 inch thick MERV-13 efficiency in angular frame mount and shall slide into galvanized steel racks.

**2.8 GAS FURNACE**

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
  - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
  - 1. Fuel: Natural gas.
  - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Venting: Gravity vented with vertical extension.
- E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.
- F. Safety Controls:
  - 1. Gas Control Valve: heaters shall have minimum turn down ratio of 4 to 1.
  - 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.

**2.9 DAMPERS**

- A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
  - 1. Damper Motor: Modulating with adjustable minimum position.
  - 2. Relief-Air Damper: Gravity actuated or motorized as indicated on drawings.

**2.10 ELECTRICAL POWER CONNECTION**

- A. Provide for single connection of power to unit with control-circuit transformer with built-in overcurrent protection.

**2.11 CONTROLS****A. DDC Controller:**

1. Manufacturer's control panel shall be able to achieve sequences of operation as indicated on drawings and as listed below.
2. Controller shall have volatile-memory backup.
3. Safety Control Operation:
  - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
  - b. Fire alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 283111 ~~%~~Digital, Addressable Fire-Alarm System+and Section 283112 ~~%~~Zoned (DC Loop) Fire-Alarm System.
  - c. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
4. Scheduled Operation: The unit shall be started and stopped through the BMS System as indicated on the drawings.
5. Refrigerant Circuit Operation:
  - a. Cycle or stage compressors to match compressor output to cooling load to maintain discharge temperature. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
6. Gas Furnace Operation:
  - a. Stage burner to maintain temperature, room or discharge air temperature.

**B. Interface Requirements for HVAC Instrumentation and Control System.**

1. Provide Modbus compatible interface for central BMX control workstation for the following:
  - a. Adjusting set points.
  - b. Monitoring supply fan start, stop, and operation.
  - c. Inquiring data to include outdoor-air damper position supply-and room-air temperature.
  - d. Monitoring occupied and unoccupied operations.
  - e. Monitoring constant and variable motor loads.
  - f. Monitoring variable-frequency drive operation.
  - g. Monitoring cooling load.
  - h. Monitoring economizer cycles.
  - i. Monitoring air-distribution static pressure and ventilation air volume.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Roof Curb: Install on roof structure base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

**3.3 CONNECTIONS**

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination at top of roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
  - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
  - 4. Install return-air duct continuously through roof structure.

**3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Refer to Specification Section 019113, General Commissioning Requirements.

**3.5 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
  - a. Start refrigeration system.
  - b. Do not operate below recommended low-ambient temperature.
  - c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
  - a. Measure gas pressure on manifold.
  - b. Inspect operation of power vents.
  - c. Measure combustion-air temperature at inlet to combustion chamber.
  - d. Measure flue-gas temperature at furnace discharge.
  - 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.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:
  - a. Coil leaving-air, dry- and wet-bulb temperatures.
  - b. Coil entering-air, dry- and wet-bulb temperatures.
  - c. Outdoor-air, dry-bulb temperature.
  - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
  - a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outdoor-air intake volume.
26. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.

- b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
- 27. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

### **3.6 CLEANING AND ADJUSTING**

- A. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

### **3.7 DEMONSTRATION**

- A. Refer to Specification Section 019113, General Commissioning Requirements

**END OF SECTION 23 7414**





**SECTION 23 8126****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.
- B. Related Sections:
  - 1. Division 1, Section 960 General Commissioning Requirements+

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. LEED Submittals:
  - 1. Product Data for Credit EA 4: For refrigerants, documentation including printed statement that refrigerants are free of HCFCs.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- G. Warranty: Sample of special warranty.

**1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. 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 62.1-2004, 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 90.1-2004.

**1.5 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

**1.6 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 years from date of Substantial Completion.
    - b. For Parts: Five years from date of Substantial Completion.
    - c. For Labor: Five years from date of Substantial Completion.

**1.7 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set for each air-handling unit.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Daikin McQuay
3. LG
4. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
5. SANYO North America Corporation; SANYO Fisher Company.
6. Trane.
7. YORK; a Johnson Controls company.

## **2.2 INDOOR UNITS 5 TONS (18 kW) OR LESS**

### **A. Concealed Evaporator-Fan Components:**

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
6. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "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.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
8. Filters: 1-inch throwaway MERV-8 unless required to be MERV-13 as noted on the equipment schedule.
9. 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 to comply with ASHRAE 62.1-2004.
    - 2) Depth: A minimum of 2 inches (50 mm) deep.
  - b. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
    - 1) Minimum Connection Size: NPS 1 (DN 25).

### **B. Wall-Mounted, Evaporator-Fan Components:**

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Enclosure Type: Totally enclosed, fan cooled.
  - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
  - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
  - f. Mount unit-mounted disconnect switches on interior of unit.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
7. 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 to comply with ASHRAE 62.1-2004.
    - 2) Depth: A minimum of 1 inch (25 mm) deep.
  - b. Single-wall, stainless-steel sheet.
  - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
    - 1) Minimum Connection Size: NPS 1 (DN 25).
8. Air Filtration Section:
  - a. General Requirements for Air Filtration Section:
    - 1) Comply with NFPA 90A.
    - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
    - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
  - b. Disposable Panel Filters:
    - 1) Factory-fabricated, viscous-coated, flat-panel type.
    - 2) Thickness: 1 inch (25 mm).
    - 3) Merv according to ASHRAE 52.2: 8, unless required to be MERV-13 as noted on the equipment schedule.

- 4) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
- 5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

### **2.3 OUTDOOR UNITS (5 TONS (18 kW) OR LESS)**

#### **A. Air-Cooled, Compressor-Condenser Components:**

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - c. Refrigerant Charge: R-410A.
  - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
7. Mounting Base: Polyethylene.

### **2.4 ACCESSORIES**

- #### **A. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:**
1. Compressor time delay.
  2. 24-hour time control of system stop and start.
  3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
  4. Fan-speed selection including auto setting.
- #### **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.**
- #### **D. Drain Hose: For condensate.**

**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 ground-mounted, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base that is 4 inches (100 mm) larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- D. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
- E. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- F. See Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- G. 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 Division 23 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 Division 23 Section "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 Division 23 Section "Air Duct Accessories."

**3.3 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Refer to Specification Section 019113, General Commissioning Requirements.

**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. Refer to Specification Section 019113, General Commissioning Requirements

**END OF SECTION 23 8126**





**SECTION 23 8239****UNIT HEATERS****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. Cabinet unit heaters with centrifugal fans and hot-water or electric-resistance heating coils.
  - 2. Propeller unit heaters with hot-water or electric-resistance heating coils.
  - 3. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.
- B. Related Sections:
  - 1. Division 1, Section 9600 General Commissioning Requirements+

**1.3 DEFINITIONS**

- A. BAS: Building automation system.
- B. CWP: Cold working pressure.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

**1.4 SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. LEED Submittal:
  - 1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

**1.5 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

**1.6 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Cabinet Unit Heater Filters: Furnish one spare filters for each filter installed.

**PART 2 - PRODUCTS****2.1 CABINET UNIT HEATERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Berko Electric Heating; a division of Marley Engineered Products.
  - 2. Carrier Corporation.
  - 3. Chromalox, Inc.; a division of Emerson Electric Company.
  - 4. Indeeco.
  - 5. Markel Products; a division of TPI Corporation.
  - 6. Marley Electric Heating; a division of Marley Engineered Products.
  - 7. McQuay International.
  - 8. QMark Electric Heating; a division of Marley Engineered Products.
  - 9. Sterling
  - 10. Trane.
- B. Description: A factory-assembled and -tested unit complying with ARI 440.
  - 1. Comply with UL 2021.
- C. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be erosion-resistant coating to prevent erosion of glass fibers.
  - 1. Thickness: 1 inch (25 mm).
  - 2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F (0.037 W/m x K at 24 deg C) mean temperature.
  - 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
  - 4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
  - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

- D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
1. Vertical Unit, Exposed Front Panels: Minimum 16 gauge sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
  2. Horizontal Unit, Exposed Bottom Panels: Minimum 16 gauge sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
  3. Recessing Flanges: Steel, finished to match cabinet.
  4. Control Access Door: Key operated.
  5. Base: Minimum 0.0528-inch- (1.35-mm-) thick steel, finished to match cabinet, 4 inches (100 mm) high with leveling bolts.
  6. Extended Piping Compartment: 8-inch- (200-mm-) wide piping end pocket.
  7. False Back: Minimum 0.0428-inch- (1.1-mm-) thick steel, finished to match cabinet.
- E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated: 90 percent arrestance and 7 MERV.
- F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain.
- G. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
- H. Fan and Motor Board: Removable.
1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
  2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- I. Basic Unit Controls:
1. Control voltage transformer.
  2. Wall-mounting thermostat with the following features.
    - a. Heat-off switch.
    - b. Fan on-auto switch.
    - c. Manual fan speed switch.
    - d. Adjustable deadband.
    - e. Concealed set point.
    - f. Exposed indication.
    - g. Deg F indication.
- J. Electrical Connection: Factory wire motors and controls for a single field connection.
- K. Capacities and Characteristics:

1. Cabinet:
  - a. Vertical, Surface Mounted: Upflow.
    - 1) Top: Flat or sloped.
    - 2) Air Inlet: Open bottom.
    - 3) Air Outlet: Front or top, extruded-aluminum bar grille.
  - b. Vertical, Fully Recessed:
    - 1) Air Inlet: Duct connection.

## 2.2 PROPELLER UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Airtherm; a Mestek Company.
  2. Engineered Air Ltd.
  3. McQuay International.
  4. QMark Electric Heating; a division of Marley Engineered Products.
  5. Sterling
  6. Trane.
- C. Description: An assembly including casing, coil, fan, and motor in vertical horizontal discharge configuration with adjustable discharge louvers.
- D. Comply with UL 2021.
- E. Comply with UL 823.
- F. Cabinet: Removable panels for maintenance access to controls.
- G. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- I. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- J. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.
- K. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch (4 mm). Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F (288 deg C) at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
  2. Wiring Terminations: Stainless-steel or corrosion-resistant material.
- L. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- M. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Type: Permanently lubricated, multispeed.
- N. Control Devices:
1. Wall-mounting, fan-speed switch.
  2. Wall-mounting thermostat.

### **2.3 WALL AND CEILING HEATERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berko Electric Heating; a division of Marley Engineered Products.
  2. Chromalox, Inc.; a division of Emerson Electric Company.
  3. Indeeco.
  4. Markel Products; a division of TPI Corporation.
  5. Marley Electric Heating; a division of Marley Engineered Products.
  6. QMark Electric Heating; a division of Marley Engineered Products.
  7. Sterling
  8. Trane.
- C. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- D. Cabinet:
1. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
  2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
  3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- E. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.
- F. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

- G. Fan: Aluminum propeller directly connected to motor.
  - 1. Motor: Permanently lubricated, multispeed. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- H. Controls: Unit-mounted thermostat.
- I. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants."
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Install propeller unit heaters level and plumb.
- D. Vibration isolators are specified in Division 23 Section "Vibration
- E. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.

- C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
- E. Comply with safety requirements in UL 1995.
- F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections and prepare test reports: Refer to Specification Section 019113, General Commissioning Requirements.

### **3.5 ADJUSTING**

- A. Adjust initial temperature set points.

**END OF SECTION 23 8239**





**SECTION 26 0500****COMMON WORK RESULTS FOR ELECTRICAL****PART 1 - GENERAL**

- 1.0** Provide labor, materials, equipment, testing, and services, and perform all operations required for the complete electrical system as specified herein or shown on the accompanying drawings.

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Apply to work of this section and all following other Sections of Division 23, 26, 27 & 28 specifications.

**1.2 SUMMARY**

- A. Section Includes:
1. Sleeves for raceways and cables.
  2. Sleeve seals.
  3. Grout.
  4. Common electrical installation requirements.

**1.3 REGULATIONS**

- A. The latest effective publications of the following codes, standards, etc., as applicable, shall form a part of the specification and drawing, as if written herein, and shall form the basis for minimum requirements. The maximum requirements shall not relieve the Contractor from providing a high grade of materials and workmanship where specified herein. Where local codes and regulations have requirements in excess of those shown on the drawings or specifications, the local requirements shall be provided by Contractor at no additional cost to the Owner. After completion of work, the Electrical Contractor shall furnish to the Owner a Certificate of final inspection.
1. The Local Electrical Code.
  2. The National Electrical Code.
  3. The Local Building Code.
  4. The Life Safety Code.
  5. OSHA and MOSHA.
  6. Rules and Regulations of Potomac Electric Power Co.

7. Rules and Regulations of Verizon Telephone Co.
  8. The Americans with Disabilities Act.
  9. Design Guidelines and Standards of Montgomery County's Division of Facilities and Services.
  10. National Fire Association.
  11. National Electrical Manufacturers Association.
  12. American Society of Testing Materials.
  13. Underwriters Laboratories.
- B. All work shall comply with the Americans with Disabilities Act (ADA) requirements and the Design Guidelines and Standards of the Department of General ServicesDBDC. If any work does not meet these requirements it shall be brought to the Architect's attention prior to ordering or fabrication.

#### **1.4 DEFINITIONS**

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.

#### **1.5 SUBMITTALS**

- A. Product Data: For sleeve seals.

#### **1.6 COORDINATION**

- A. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  3. To allow right of way for piping and conduit installed at required slope.
  4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

**PART 2 - PRODUCTS****2.1 SLEEVES FOR RACEWAYS AND CABLES**

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches thickness shall be 0.052 inch
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch

**2.2 SLEEVE SEALS**

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
  - 3. Pressure Plates: Plastic. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

**2.3 GROUT**

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

**PART 3 - EXECUTION****3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION**

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

**3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
  - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

### **3.3 SLEEVE-SEAL INSTALLATION**

- A. Install to seal all exterior and interior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.4 FIRESTOPPING**

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

**END OF SECTION 26 0500**



**SECTION 26 0519****LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES****PART 1 - GENERAL**

- 1.0** Provide all labor, and materials of low voltage electrical power conductors and cables required for complete installation of all electrical work as specified and shown on the drawings. All work shall be subject to the Engineer's review and acceptance.

**1.1 SUMMARY**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this and the other Sections of Division 23, 26, 27 & 28.
- B. This Section includes the following:
  - 1. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.
  - 3. Sleeves and sleeve seals for cables.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

**PART 2 - PRODUCTS****2.1 CONDUCTORS AND CABLES**

- A. Copper Conductors: Comply with NEMA WC 70.
- B. All conductors shall be soft drawn copper of not less than 98 percent conductivity. No aluminum conductors allowed. All conductors shall be covered with 600 volt insulation, minimum rated at 75° C.

- C. Insulation . In normally dry locations, branch circuit conductors shall have Type THW or THWN insulation. In normally damp or wet locations, branch circuit conductors shall have type THW or THWN insulation. Main feeders shall be THW or THHN.
- D. Size . Branch circuit conductors shall be minimum No. 12 AWG copper unless otherwise noted; homeruns to panelboard shall be minimum No. 10 AWG copper, when length exceeds 75 feet. Fire alarm wiring shall be minimum #14 AWG. See fire alarm specifications. Feeder conductors shall be sized for a maximum voltage drop of 2% at full connected load. Branch circuits shall be sized for a maximum voltage drop of 3% at full connected load. Control circuit conductors shall be a minimum No. 14 AWG copper.
- E. No cable shall be used in masonry partitions.
- F. All conductors shall have the following information surface printed throughout the entire length of the conductor.
  - 1. Cable Manufacturer
  - 2. Trade Name of Wire
  - 3. Type of insulation.
  - 4. Voltage Classification
  - 5. Size of Wire
  - 6. Color Coded
- G. Acceptable manufacturers for wires:
  - 1. Southwire Company
  - 2. Allied Wire and Cable Company
  - 3. American Flexible Conduit Co.

## **2.2 CONNECTORS AND SPLICES**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Insulated Wire Corp.
  - 2. General Cable Corporation.
  - 3. Senator Wire & Cable Company.
  - 4. Southwire Company.



- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

## **2.3 SLEEVES FOR CABLES**

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

## **2.4 SLEEVE SEALS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. Calpico, Inc.
  - 3. Metraflex Co.
  - 4. Pipeline Seal and Insulator, Inc.
- D. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
  - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
  - 2. Pressure Plates: Plastic. Include two for each sealing element.
  - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## **PART 3 - EXECUTION**

### **3.1 CONDUCTOR MATERIAL APPLICATIONS**

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Use #10AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

### **3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS**

- A. Service Entrance: Type THHN-THWN, single conductors in raceway Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, metal-clad, type MC cable.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited tray cable, in cable tray.

### **3.3 INSTALLATION OF CONDUCTORS AND CABLES**

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Conduits shall run concealed except electrical, mechanical spaces, apparatus bays. Exposed conduits shall be grouped in neat parallel lines properly supported, following the lines of the building structure as close as possible and as directed. Upon completion of all runs, all conduits shall be properly sealed until ready to pull wires.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

- F. Identify and color-code conductors and cables according to Division 26 Section " Identification for Electrical Systems."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
  - 1. Make splices only in outlet boxes, junction and pull boxes, manholes and handholes.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

### **3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- D. Cut sleeves to length for mounting flush with both wall surfaces.
- E. Extend sleeves installed in floors 2 inches above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 7 Section "Joint Sealants."
- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 7 Section "Through-Penetration Firestop Systems."
- J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

### **3.5 SLEEVE-SEAL INSTALLATION**

- A. Install to seal underground exterior-wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.6 FIRESTOPPING**

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 7 Section "Through-Penetration Firestop Systems."

### **3.7 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
    - a. Emergency and Critical Fire Protection Equipment.
    - b. Communications and Alarm / Security Monitoring Supply Circuits.
    - c. HVAC and Mechanical Load Circuits.
    - d. Electrical load balance.
    - e. Public Address or WestNet System.
    - f. Emergency generator and automatic transfer switches load circuits.
    - g. Grounding and bonding wiring circuits.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

- a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
  - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
4. Before final acceptance, the Contractor shall make voltage, insulation and load tests, necessary to demonstrate to the Owner the satisfactory installation and proper performance of all feeder circuits.
  5. Test feeder conductors to determine the conductors are clear of faults, high resistance connections and megger test same at 600 volts DC. Test results below 30 megaohms shall be cause for rejection of the wiring installation. Replace and retest all such rejected conductors.
- C. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
  2. Test results that comply with requirements.
  3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

**END OF SECTION 26 0519**



**SECTION 26 0526****GROUNDING AND BONDING****PART 1 - GENERAL**

- 1.0** Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings and as specified herein.

**1.1 SUMMARY**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this and the other Sections of Division 23, 26, 27 & 28.
- B. This Section includes methods and materials for grounding systems and equipment.
  - 1. Power system grounding.
  - 2. Communication and other system grounding.
  - 3. Other utilities system grounding.
  - 4. Equipment grounding.
  - 5. Raceways and Boxes, Wires and Cables, Switches, Panelboards, and Transformers etc.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

**PART 2 - PRODUCTS**

**2.1 CONDUCTORS**

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

**B. Bare Copper Conductors:**

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

**2.2 CONNECTORS**

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
  1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

**2.3 GROUNDING ELECTRODES**

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 by 10 inches in diameter.

**PART 3 - EXECUTION****3.1 APPLICATIONS**

- A. Conductors: Install solid green conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade. Connect to ground rod.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
  1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  2. Underground Connections: Welded connectors; except at test wells and as otherwise indicated.
  3. Connections to Ground Rods at Test Wells: Bolted connectors.



4. Connections to Structural Steel: Welded connectors.

### **3.2 EQUIPMENT GROUNDING**

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  1. Feeders and branch circuits.
  2. Lighting circuits.
  3. Receptacle circuits.
  4. Single-phase motor and appliance branch circuits.
  5. Three-phase motor and appliance branch circuits.
  6. Flexible steel raceway runs.
  7. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
  8. Communication and security system circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
  1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
  2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### **3.3 INSTALLATION**

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
  1. Interconnect ground rods with #4/0 grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor with #4/0 conductor with UL listed connection hardware.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes shall be at least 12 inches deep, with cover.
1. Test Wells: Install at least ~~two~~one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a listed bolted clamp.
- E. **Grounding and Bonding for Piping:**
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
    - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

- b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Report measured ground resistances that exceed the following values:
  - 1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 5 ohms.
  - 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
  - 3. Power Distribution Units or Blank Panelboards Serving Electronic Equipment: 3 ohm(s).
  - 4. (3) ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect and Owner promptly and include recommendations to reduce ground resistance. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Owner. Final tests must ensure that this requirement is met.
- D. Prepare certification report that identifies grounding checked and that describes grounding results. Include notation of the deficiencies, corrective action taken and observations after corrective action.
- E. Provide written test procedure and report showing all test results for A/E and owner approval.
- F. The system shall be final tested in the presence of the owner representative.

**END OF SECTION 26 0526**

**SECTION 26 0529****HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

**1.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

**1.3 SUBMITTALS**

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel slotted channel systems. Include Product Data for components.
  - 3. Equipment supports.
- C. Welding certificates.

**1.4 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

**PART 2 - PRODUCTS****2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
  - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Hilti Inc.
  - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
  - 3) MKT Fastening, LLC.
  - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
    - 2) Empire Tool and Manufacturing Co., Inc.
    - 3) Hilti Inc.
    - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  1. Secure raceways and cables to these supports with single-bolt conduit clamps.

- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### **3.2 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### **3.3 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

**3.4 CONCRETE BASES**

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

**3.5 PAINTING**

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 9 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION 26 0529**



**SECTION 26 0533****RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL**

- 1.0** Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

**1.1 SUMMARY**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Apply to work of this section and all following other Sections of Division 23, 26, 27 & 28 specifications.
- B. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

**1.2 SUBMITTALS**

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

**PART 2 - PRODUCTS**

**2.1 METAL CONDUIT AND TUBING**

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. EMT: ANSI C80.3.
- D. FMC: Zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket.

- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
  - 2. Fittings for EMT: Steel or die-cast, or compression type.

## **2.2 METAL WIREWAYS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper B-Line, Inc.
  - 2. Hoffman.
  - 3. Square D; Schneider Electric.
- C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, 12 or 3R, unless otherwise indicated for listed application.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Screw-cover type.
- F. Finish: Manufacturer's standard enamel finish.

## **2.3 SURFACE RACEWAYS**

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Thomas & Betts Corporation.
    - b. Walker Systems, Inc.; Wiremold Company (The).
    - c. Wiremold Company (The); Electrical Sales Division.

## **2.4 BOXES, ENCLOSURES, AND CABINETS**

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

- C. Nonmetallic Floor Boxes: Nonadjustable, round.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Nonmetallic Enclosures: Plastic.
- G. Cabinets:
  - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.

### **PART 3 - EXECUTION**

#### **3.1 RACEWAY APPLICATION**

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
  - 1. Concealed Conduit: Rigid steel conduit, Type EPC-40-PVC.
  - 2. Concealed Conduit, Aboveground: Rigid steel conduit EMT.
  - 3. Underground Conduit: Type EPC-40-PVC or EPC-PVC 80.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 5. Boxes and Enclosures, Exterior areas: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
  - 1. Installation of the exposed conduits shall be limited to mechanical, electrical runs, apparatus bay.
  - 2. Exposed, Not Subject to Physical Damage: EMT.
  - 3. Exposed, Not Subject to Severe Physical Damage: EMT.
  - 4. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  - 5. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  - 7. Damp or Wet Locations: Rigid steel conduit.

8. Raceways for Optical Fiber or Communications Cable: EMT.
  9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size and 1-inch trade size for communication, underslabs and all exterior circuits.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

### 3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Electrical Supports and Seismic Restraints."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches (of slack at each end of pull wire.
- K. Raceways for Optical Fiber and Communications Cable: Install as follows:
1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet
  2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet
  3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where otherwise required by NFPA 70.
- M. Flexible Steel Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
- N. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- O. Set metal floor boxes level and flush with finished floor surface.
- P. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- Q. Anchor and brace all cabling, material, and equipment installed under this Division as required by all codes, regulations, and standards. Provide required supports, beams, angles, hangers, rods, bases, braces, straps, struts, and other items to properly support project work.

### **3.3 INSTALLATION OF UNDERGROUND CONDUIT**

- A. Schedule 40 PVC-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
  - 2. Install backfill as specified in Division 31 Section "Earthwork."
  - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earthwork."
  - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
  - 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
  - 6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, located 24 inches on center. Align planks along the width and along the centerline of conduit.

**3.4 FIRESTOPPING**

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."
- B. Patch and seal all openings remaining around and inside all new and existing conduit sleeves and cable penetrations to maintain the integrity of any fire-rated wall, floor, ceiling, etc.

**END OF SECTION 26 0533**

**SECTION 26 0553****IDENTIFICATION FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL**

- 1.0** Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein.

**1.1 SUMMARY**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Apply to work of this section and all following other Sections of Division 23, 26, 27 & 28.
- B. Section Includes:
1. Identification for raceways.
  2. Identification of power and control cables.
  3. Identification for conductors.
  4. Underground-line warning tape.
  5. Warning labels and signs.
  6. Instruction signs.
  7. Equipment identification labels.
  8. Junction and pull box identification.
  9. Communication and security system identification and labeling.
  10. Fire alarm system.
  11. Miscellaneous identification products.

**1.2 SUBMITTALS**

- A. Product Data: For each electrical identification product indicated.

**1.3 QUALITY ASSURANCE**

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

**PART 2 - PRODUCTS****2.1 POWER RACEWAY IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

**2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.



**2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

**2.4 CONDUCTOR IDENTIFICATION MATERIALS**

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags: Polyester tag, 0.010 inch) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

**2.5 FLOOR MARKING TAPE**

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

**2.6 UNDERGROUND-LINE WARNING TAPE****A. Tape:**

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

**B. Color and Printing:**

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

**C. Tag: Type I:**

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils
3. Weight: 18.5 lb/1000 sq. ft.
4. 3-Inch Tensile According to ASTM D 882: 30 lbf. and 2500 psi

**D. Tag: Type ID:**

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf and 4600 psi .

**2.7 WARNING LABELS AND SIGNS****A. Comply with NFPA 70 and 29 CFR 1910.145.****B. Self-Adhesive Warning Labels:** Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.**C. Baked-Enamel Warning Signs:**

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches .

**D. Metal-Backed, Butyrate Warning Signs:**

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES "
3. Insert names and wording of warning signs or labels; e.g., arc-flash, multiple services and voltages, and others.

## **2.8 INSTRUCTION SIGNS**

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend with black letters on white face.
  2. Punched or drilled for mechanical fasteners.
  3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

## **2.9 EQUIPMENT IDENTIFICATION LABELS**

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch .

## **2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS**

- A. Paint: Comply with requirements in Division 9 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- G. Painted Identification: Comply with requirements in Division 9 painting Sections for surface preparation and paint application.

**3.2 IDENTIFICATION SCHEDULE**

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 10-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Emergency Power.
  - 2. Power.
  - 3. UPS.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    - b. Colors for 208/120-V Circuits:

- 1) Phase A: Black
- 2) Phase B: Red
- 3) Phase C: Blue
- 4) Neutral: White
- 5) Ground: Green

c. Colors for 480/477-V Circuits:

- 1) Phase A: Brown
- 2) Phase B: Orange
- 3) Phase C: Yellow
- 4) Neutral: White w/color stripe
- 5) Ground: Green

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
  2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
  2. Identify system voltage with black letters on an orange background.
  3. Apply to exterior of door, cover, or other access.
  4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.

- b. Controls with external control power connections.
  - J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
  - K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
  - L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
- 1. Labeling Instructions:
    - a. All labels shall be permanent, and machine generated. **NO HANWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED.**
    - b. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inchhigh label; where two lines of text are required, use labels 2 inches high.
    - c. Outdoor Equipment: Engraved, laminated acrylic Stenciled legend 4 inches high.
    - d. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    - e. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

**END OF SECTION 26 0553**

**SECTION 260800****ELECTRICAL SYSTEM COMMISSIONING****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The purpose of this section is to specify Division 26 responsibilities in the commissioning process which are being directed by the Commissioning Authority (CxA). Other electrical systems testing may be required under the direction of the General Contractor (GC).
- B. The list of commissioned equipment and systems is found in Section 01 75 00.
- C. Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 75 00. Division 26 shall be familiar with all parts of Section 01 75 00 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

**1.2 DEFINITIONS**

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- D. Refer to section 017500 for additional definitions related to the commissioning process.

**1.3 INFORMATION SUBMITTALS**

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.
- C. All third party reports and test information required by other Division 26 Sections.

**1.4 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: As specified in each Section containing electrical testing requirements and in subparagraph and associated subparagraph below:
  - 1. Independent Testing Agencies: Independent of manufacturers, suppliers, and installers of components to be tested or inspected.
    - a. Testing Agency's Field Supervisor for Power Component Testing: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Division 26 power component Sections.
  - 2. Test Equipment Suitability: Comply with NETA ATS, Section 5.2
  - 3. Test Equipment Calibration: Comply with NETA ATS, Section 5.3

**1.5 RESPONSIBILITIES**

A. Electrical Contractors

The commissioning responsibilities applicable to the electrical contractor are as follows (all references apply to commissioned equipment):

1. Construction and Acceptance Phases

- a. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
- b. Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment.
- c. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of startup and functional testing procedures.
  - 1) Typically this will include detailed manufacturer installation and startup, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
  - 2) The CxA may request further documentation necessary for the commissioning process.
  - 3) This data request may be made prior to normal submittals.
- d. Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CxA for review.
- e. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- f. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- g. Develop a full startup and initial checkout plan using manufacturer's startup procedures and the pre-functional checklists from the CxA. Submit manufacturer's detailed startup procedures and the full startup plan and procedures and other requested equipment documentation to CxA for review.
- h. During the startup and initial checkout process, execute and document the electrical related portions of the pre-functional checklists provided by the CxA for all commissioned equipment.
- i. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
- j. Address current A/E punch list items before functional testing.
- k. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- l. Perform functional performance testing under the direction of the CxA for specified in 01 75 00. Assist the CxA in interpreting the monitoring data, as necessary.
- m. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC and A/E and retest the equipment.
- n. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- o. During construction, maintain as-built red-line drawings for all drawings and final CAD as-built for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built draw-



ings for all drawings and final as-builts for contractor-generated coordination drawings.

- p. Provide training of the Owner's operating personnel as specified.
- q. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

## 2. Warranty Period

- a. Execute deferred functional performance testing, witnessed by the CxA, according to the specifications.
- b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

## 1.6 COMMISSIONING DOCUMENTATION

- A. Contractor to provide the following information to the CxA for inclusion in the commissioning plan:
  - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports
  - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Division 23 systems, assemblies, equipment, and components to be verified and tested.
  - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
  - 5. Certificate of readiness certifying that Division 23 systems, subsystems, equipment, and associated controls are ready for testing.
  - 6. Test and inspection reports and certificates.
  - 7. Corrective action documents.

## 1.7 RELATED WORK

- A. Refer to Section 01 75 00 for a listing of all sections where commissioning requirements are found.
- B. Refer to Section 01 75 00 and Section 3.9 for systems to be commissioned and functional testing requirements.
- C. The Div. 26 contractor shall provide all labor and materials to fully support Div. 23 HVAC systems start up field quality control, pre-commissioning and commissioning. The Div. 26 contractor shall perform all required electrical portions of the Div. 23 commissioning. As part of this requirement, indicate by signature when check list items are complete where so indicated in the Div. 23 checklists.
- D. Coordinate all provisions and installations of Div. 26 and 28 with the hardware schedule indicated on the Architectural drawings.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT

- A. Division 26 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

- B. Refer to Section 01 75 00 for additional Division 26 requirements.

### **PART 3 - EXECUTION**

#### **3.1 STARTUP**

- A. The electrical contractors shall follow the startup and initial checkout procedures listed in the Responsibilities list in this section and in 01 75 00. Division 26 has startup responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and GC. Beginning system testing before full completion does not relieve the Contractor of responsibility for fully completing the system, including all pre-functional checklists as soon as possible.

#### **3.2 GENERAL TESTS AND INSPECTIONS**

- A. If a group of tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:
1. Perform insulation-resistance tests.
  2. Perform continuity tests.
  3. Perform rotation test (for motors to be tested).
  4. Provide a stable source of single-phase, 208/120-V electrical power for test instrumentation at each test location.
- B. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:
1. Manufacturer's written testing and inspecting instructions.
  2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
  3. Tabulation of expected measurement results made before measurements.
  4. Tabulation of "as-found" and "as-left" measurement and observation results.
  5. Tabulate the calculated and measured voltage drop to each panelboard and large equipment.
- C. Feeders:
1. Include in testing, ground, resistance, conducting, and torque testing on all newly installed feeders. This applies to all feeders to panelboards and individual pieces of HVAC equipment.
  2. Test shall be from and including lugs of originating source to terminal lugs @ equipment listed above.
    - a. Test ground continuity throughout circuit per NETA Standards.
    - b. Test resistivity of insulation for each feeder conductor per tables and text in NETA Standards.

- c. Test and verify conductance per NETA Standards, wire manufacturers recommendations, and applicable U.L. Standards. Check torque at all lugs. Retorque where appropriate ft. pound valve at termination does not meet cable manufacturer specifications, U.L. standards for tested cable, and NETA Test Standards.
  - d. Contractor shall also adhere to my requirements of the Loudoun County Building Officials with respect to feeder requirements.
- 3. The Contractor shall record in writing the results for each test parameter at each feeder and submit to the Owner, CxA and the EOR prior to beginning any work in subject panelboard.
- 4. The Contractor includes in bid price, the full services of a certified, independent electrical testing organization approved by the Owner. The independent testing organization must be certified and have ten (10) or more years in demonstrated experience in testing and analyzing conditions and performance of all items within the scope of work.
- 5. Voltage Drop: Calculate, then measure the voltage drop at all feeders from the switchboard through the system to each panelboard.
- 6. Where large equipment is connected, measure the voltage drop to the equipment at full load.

### **3.3 FUNCTIONAL PERFORMANCE TESTS**

- A. Refer to Section 01 75 00 for a list of systems to be commissioned.
- B. This section shall not exempt contractual requirements to perform other tests, etc. throughout each and every Division 26 Specification section.
- C. This Section includes general requirements for electrical field testing and inspecting. Without exception, the Contractor is responsible and bid price includes all testing referenced within this section and all other Div. 26 sections. General requirements include the following:
  - 1. Qualifications of testing agencies and their personnel.
  - 2. Suitability of test equipment.
  - 3. Calibration of test instruments.
  - 4. Coordination requirements for testing and inspecting.
  - 5. Reporting requirements for testing and inspecting.
- D. Additional tests will be developed for other systems listed in Section 3.9 based on final electrical system design and submitted and approved products.

### **3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS**

- A. Refer to Section 01 75 00 for specific details on non-conformance issues relating to pre-functional checklists and tests.
- B. Refer to Section 01 75 00 for issues relating to functional performance tests.

### **3.5 OPERATIONS AND MAINTENANCE (O&M) MANUALS**

- A. Division 26 shall compile and prepare documentation for all equipment and systems covered in Division 26 and deliver to the GC for inclusion in the O&M manuals, according to Sections 01 33 00 and 01 77 00.
- B. The CxA shall receive a copy of the O&M manuals for concurrent review.

### **3.6 TRAINING OF OWNER PERSONNEL**

- A. The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 75 00 for additional details.
- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 75 00 for additional details.
- C. The electrical contractor shall have the following training responsibilities:
  - 1. Provide the CxA with a training plan eight (8) weeks before the planned training according to the outline described in Section 01 75 00.
  - 2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
  - 3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
  - 6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  - 7. Training shall include:
    - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
    - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
    - c. Discuss relevant health and safety issues and concerns.
    - d. Discuss warranties and guarantees.
    - e. Cover common troubleshooting problems and solutions.
    - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
    - g. Discuss any peculiarities of equipment installation or operation.
    - h. The format and training agenda in Guidelines for Commissioning HVAC Systems, ASHRAE, Guideline 0-2005 is recommended.
    - i. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
  - 8. Hands-on training shall include startup, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
  - 9. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
  - 10. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

11. Duration of Training: The electrical contractor shall provide training on each piece of equipment.

Hours per System

- 4 Lighting Controls  
14 Life Safety Systems  
6 Emergency power systems  
8 Classroom Technology

12. Videotaping as described in Section 01 75 00.

**3.7 DEFERRED TESTING**

- A. Refer to Section 01 75 00 for requirements of deferred testing.

**3.8 WRITTEN WORK PRODUCTS**

- A. Written work products of Contractors will consist of the startup and initial checkout plan described in Section 01 75 00 and the filled out startup, initial checkout and pre-functional checklists.

**3.9 EQUIPMENT AND ASSOCIATED SYSTEMS TO BE COMMISSIONED**

SPEC. SECTION	SYSTEM DESCRIPTION	SAMPLING
260923	LIGHTING CONTROL DEVICES	100%
262200	LOW VOLTAGE TRANSFORMERS	20%
263213	ENGINE GENERATORS	100%
263600	TRANSFER SWITCHES	100%
265100	INTERIOR LIGHTING	100%
265600	EXTERIOR LIGHTING	100%

Note: Provide separate checklist for each unit. Complete for each unit prior to substantial completion.

**END OF SECTION 26 08 00**



**SECTION 26 0923****LIGHTING CONTROL DEVICES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following lighting control devices:
  - 1. Time switches.
  - 2. Outdoor photoelectric switches.
  - 3. Indoor occupancy sensors.
  - 4. Lighting contactors.
  - 5. Emergency shunt relay.
- B. See Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches. Use specification grade products. Do not use residential grade products.
- C. "Dimming Controls" for architectural dimming system equipment. Use Lutron T-Star or equivalent dimmers if specified in lighting drawings.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

**PART 2 - PRODUCTS****2.1 TIME SWITCHES**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Intermatic, Inc.
  - 2. Paragon Electric Co.; Invensys Climate Controls.
  - 3. TORK.

- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
1. Contact Configuration: DPDT.
  2. Contact Rating: 30-A inductive or resistive, or 240-V ac 20-A ballast load, 120/240-V ac.
  3. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
  4. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
  5. Programs: 3 channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule.
  6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
  7. Astronomic Time: Selected channels.
  8. Battery Backup: For schedules and time clock.

## 2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Intermatic, Inc.
  2. Lithonia Lighting; Acuity Lighting Group, Inc.
  3. Novitas, Inc.
  4. Paragon Electric Co.; Invensys Climate Controls.
  5. TORK.
  6. Touch-Plate, Inc.
  7. Watt Stopper (The).
- B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Light-Level Monitoring Range: 1.5 to 10 fc with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
  2. Time Delay: 15-second minimum, to prevent false operation.
  3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
  4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
- C. Description: Solid state, with DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.
1. Light-Level Monitoring Range: 1.5 to 10 fc with an adjustment for turn-on and turn-off levels within that range.
  2. Time Delay: 30-second minimum, to prevent false operation.
  3. Lightning Arrester: Air-gap type.
  4. Mounting: Twist lock complying with IEEE C136.10, with base.



**2.3 INDOOR OCCUPANCY SENSORS**

- A. Refer to specification section 16140 for devices to be used on this project.

**2.4 LIGHTING CONTACTORS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Allen-Bradley/Rockwell Automation.
  2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
  3. Eaton Electrical Inc.; Cutler-Hammer Products.
  4. GE Industrial Systems; Total Lighting Control.
  5. Square D; Schneider Electric.
  6. TORK.
- B. Description: Electrically operated and mechanically held, combination type with fusible switch, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
  2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  3. Enclosure: Comply with NEMA 250.
  4. Provide with control and pilot devices as indicated on Drawings or scheduled, matching the NEMA type specified for the enclosure.
- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
1. Monitoring: On-off status, at Sensor.
  2. Control: On-off operation, at Switch/Relay.

**2.5 EMERGENCY SHUNT RELAY**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Lighting Control and Design, Inc.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
1. Coil Rating: As indicated on drawings.

**2.6 CONDUCTORS AND CABLES**

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 16 Section "Conductors and Cables."

### **PART 3 - EXECUTION**

#### **3.1 SENSOR INSTALLATION**

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

#### **3.2 CONTACTOR INSTALLATION**

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

#### **3.3 WIRING INSTALLATION**

- A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch .
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

#### **3.4 IDENTIFICATION**

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

**3.5 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
  - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

**END OF SECTION 26 0923**



**SECTION 26 2200****LOW-VOLTAGE TRANSFORMERS****PART 1 - GENERAL**

- 1.0** Provide and install all equipment, labor, material, accessories and mounting hardware for a complete and operating system for dry type transformers.

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
1. Distribution transformers.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate dimensions and weights.
1. Wiring Diagrams: Power, signal, and control wiring.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance data.

**1.5 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Products.
  2. General Electric Company.
  3. Siemens Energy & Automation, Inc.
  4. Square D; Schneider Electric.

**2.2 GENERAL TRANSFORMER REQUIREMENTS**

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
  2. Coil Material: Copper.

**2.3 DISTRIBUTION TRANSFORMERS**

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Totally enclosed, nonventilated, NEMA 250, Type 2.
1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
1. Finish Color: ANSI 61 gray.
- E. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.

- 2. Tested according to NEMA TP 2.
- J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
- K. Wall Brackets: Manufacturer's standard brackets.

## **2.4 IDENTIFICATION DEVICES**

- A. Nameplates: Engraved, laminated-plastic or metal nameplate. Nameplates are specified in Section 260553 "Identification for Electrical Systems."

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

### **3.2 SOURCE QUALITY CONTROL**

- A. Provide commissioning of transformers under provisions of Section 260800.
- B. Provide production testing of each unit in accordance with NEMA ST20.

### **3.3 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Check for damage and tight connections prior to energizing transformer.
- C. Measure primary and secondary voltages and make appropriate tap adjustments.
- D. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test started in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
    - a. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
    - b. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

- c. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

### **3.4 ADJUSTING**

- A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

**END OF SECTION 26 2200**



**SECTION 26 2416****PANELBOARDS****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

**1.2 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Include evidence of NRTL listing for series rating of installed devices.
  - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 7. Include wiring diagrams for power, signal, and control wiring.
  - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.
- C. Field quality-control reports.
- D. Panelboard schedules for installation in panelboards.
- E. Operation and maintenance data.

**1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.

- C. Comply with NFPA 70.

## 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Refer to panel schedules for surface or flush mounted cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3R.
    - c. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
  - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top.
- C. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Main and Neutral Lugs: Compression or Mechanical type.
  - 3. Ground Lugs and Bus Configured Terminators: Compression or Mechanical type.
  - 4. Feed-Through Lugs: Compression or Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 5. Subfeed (Double) Lugs: Compression or Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

**2.2 DISTRIBUTION PANELBOARDS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

**2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

**2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - a. Instantaneous trip.
  - b. Long- and short-time pickup levels.
  - c. Long- and short-time time adjustments.
  - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Lugs: Compression or Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
  - d. Ground-Fault Protection: Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
  - f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

## 2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and **switchboard class relays**.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Comply with NECA 1.

### **3.2 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 16 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### **3.3 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
  1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- C. Tests and Inspections:
  1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

**END OF SECTION 26 2416**

**SECTION 26 2713**  
**ELECTRICITY METERING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes work to accommodate utility company revenue meters, and Owner's electricity meters used to manage the electrical power system.

**1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For electricity-metering equipment.
  - 1. Include elevation views of front panels of control and indicating devices and control stations.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
  - 4. Include series-combination rating data for modular meter centers with main disconnect device.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Submit evidence that meters are compatible with connected monitoring and control devices.
- B. Field quality-control reports.
- C. Sample warranty.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance data.

**1.5 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An NRTL.

**1.6 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
  - 2. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

**1.7 COORDINATION**

- A. Electrical Service Connections: Coordinate with utility companies and utility-furnished components.

**PART 2 - PRODUCTS****2.1 SYSTEM DESCRIPTION**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 916.

**2.2 UTILITY METERING INFRASTRUCTURE**

- A. Install metering accessories furnished by the utility company, complying with its requirements.
- B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by the Utility.
  - 1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725.
- C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- D. Meter Sockets:



1. Comply with requirements of electrical-power utility company.
2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

E. Arc-Flash Warning Labels:

1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 260574 "Overcurrent Protective Device Arc-Flash Study." Apply a properly sized self-adhesive label at each work location included in the analysis.
2. Labels: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply a properly sized self-adhesive label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
  - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
    - 1) Location designation.
    - 2) Nominal voltage.
    - 3) Flash protection boundary.
    - 4) Hazard risk category.
    - 5) Incident energy.
    - 6) Working distance.
    - 7) Engineering report number, revision number, and issue date.

## 2.3 ELECTRICITY METERS

- A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric
  5. Emon-Dmon.
- C. Standard: Comply with ANSI C12.1 and ANSI C12.20, 0.2 accuracy class.
  1. Ambient Temperature: Minus 22 deg F to plus 158 deg F (Minus 30 deg C to plus 70 deg C).
  2. Humidity: Zero to 95 percent, noncondensing.
  3. Capacities and Characteristics:
    - a. Circuit: 120/240-V ac, 100 A.
    - b. Measure: kWh, onboard LED display.
    - c. Remote-Reading Options: None.

D. General Requirements for Meters:

1. Certify that meters comply with ANSI C12.20 requirements by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The laboratory shall use test equipment that is certified annually and is traceable to NIST standards.
2. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 1 and Type 3R minimum, with provisions for locking or sealing.
3. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
4. Onboard Nonvolatile Data Storage: kWh, until reset.
5. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
  - a. Type: Split and solid core, complying with recommendation of meter manufacturer.

E. kWh Meter: Electronic three-phase meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.
3. Display: Digital electromechanical counter, indicating accumulative kWh.

F. Remote Reading Options:

1. Serial Interface: RS-232.
2. Serial Interface: RS-485, with Modbus RTU protocol.
3. USB interface.
4. TCP/IP adapter.

G. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

H. Data Transmission Cable: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

- C. Install modular meter center according to switchboard installation requirements in NECA 400.
- D. Install arc-flash labels as required by NFPA 70.
- E. Wiring Method:
  - 1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
  - 2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271500 "Communications Copper Horizontal Cabling."
  - 3. Minimum conduit size shall be 3/4 inch.
- F. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### **3.2 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. Equipment and Software Setup:
    - a. Set meter date and time clock.
    - b. Test, calibrate, and connect pulse metering system.
    - c. Set and verify billing demand interval for demand meters.
    - d. Report settings and calibration results.
    - e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.
  - 2. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
  - 3. Turn off circuits supplied by metered feeder and secure them in off condition.
  - 4. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
  - 5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
  - 6. Generate test report and billing for each tenant or activity from the meter reading tests.
- D. Electricity metering will be considered defective if it does not pass tests and inspections.

- E. Prepare test and inspection reports.

**END OF SECTION 26 2713**

**SECTION 26 2726****WIRING DEVICES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Wall-box motion sensors.
  - 3. Snap switches and wall-box dimmers.
  - 4. Solid-state fan speed controls.
  - 5. Wall-switch and exterior occupancy sensors.
  - 6. Communications outlets.
- B. See Division 27 Section "Voice and Data Communication Cabling" for workstation outlets.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers' Names:
  - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

## **2.2 STRAIGHT BLADE RECEPTACLES**

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
  1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 5351 (single), 5352 (duplex).
    - b. Hubbell; HBL5351 (single), CR5352 (duplex).
    - c. Leviton; 5891 (single), 5352 (duplex).
    - d. Pass & Seymour; 5381 (single), 5352 (duplex).

## **2.3 GFCI RECEPTACLES**

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
  1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; GF20.
    - b. Pass & Seymour; 2084.

## **2.4 SNAP SWITCHES**

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
  1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
    - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
    - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
    - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20 A:
  1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 2221PL for 120 V and 277 V.

- b. Hubbell; HPL1221PL for 120 V and 277 V.
- c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
- d. Pass & Seymour; PS20AC1-PLR for 120 V.

- 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

## 2.5 FAN SPEED CONTROLS

- A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

- 1. Continuously adjustable toggle switch, 5 A.
- 2. Three-speed adjustable slider, 1.5 A.

## 2.6 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:

- 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Cooper.
  - b. Hubbell.
  - c. Leviton.
  - d. Pass & Seymour.
  - e. Watt Stopper (The).
- 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. Provide On-Off+ function. Furnish switches with 2-buttons were indicated on the drawings.

- B. Long-Range Wall-Switch Sensors:

- 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Hubbell.
  - b. Leviton.
  - c. Pass & Seymour.
  - d. Watt Stopper (The).
- 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft.

- C. Long-Range Wall-Switch Sensors:

- 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Hubbell; ATD1600WRP.
  - b. Leviton; ODW12-MRW.
  - c. Watt Stopper (The); DT-200.

2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.
- D. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq.in. (232 sq.cm).
  2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq.ft. (93 sq.m) when mounted on a 96-inch- (2440-mm) high ceiling.
  3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- E. Wide-Range Wall-Switch Sensors:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Hubbell.
    - b. Leviton.
    - c. Pass & Seymour.
    - d. Watt Stopper (The).
  2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.

## 2.7 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
  2. Material for Finished Space. Specification grade: white, white nylon plates.
  3. Material for Unfinished Spaces: Stainless steel.
  4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

## 2.8 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Round, solid brass with satin finish.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.



- E. Voice and Data Communication Outlet: Blank cover with bushed cable opening or Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable.

## **2.9 FINISHES**

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
  - 1. Wiring Devices Connected to Normal Power System: White or As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. TVSS Devices: Blue.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
  - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 45- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

### 3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

### 3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 2045-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

**END OF SECTION 26 2726**



**SECTION 26 2816****ENCLOSED SWITCHES AND CIRCUIT BREAKERS****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Molded-case circuit breakers (MCCBs).
  - 4. Enclosures.

**1.2 DEFINITIONS**

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

**1.4 SUBMITTALS**

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
- D. Field quality-control reports.
- E. Operation and maintenance data.

**1.5 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

**PART 2 - PRODUCTS****2.1 FUSIBLE SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 4. Lugs: Suitable for number, size, and conductor material.
  - 5. Service-Rated Switches: Labeled for use as service equipment.

**2.2 NONFUSIBLE SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Suitable for number, size, and conductor material.

## **2.3 MOLDED-CASE CIRCUIT BREAKERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
  1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Suitable for number, size, trip ratings, and conductor material.
  3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  4. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  5. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

## **2.4 ENCLOSURES**

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  2. Outdoor Locations: NEMA 250, Type 3R.
  3. Kitchen Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
  4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

### **3.2 IDENTIFICATION**

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### **3.3 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**END OF SECTION 26 2816**



**SECTION 26 3213****ENGINE GENERATORS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
  - 1. Diesel engine.
  - 2. Unit-mounted cooling system.
  - 3. Unit-mounted control and monitoring.
  - 4. Performance requirements for sensitive loads.
  - 5. Load banks.
  - 6. Outdoor enclosure.
  - 7. Remote annunciator panel.
- B. Related Sections include the following:
  - 1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

**1.3 DEFINITIONS**

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. LP: Liquid petroleum.

**1.4 SUBMITTALS**

- 1. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.

2. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
  3. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For installer testing agency.
- D. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
  2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
  3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
  4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
  5. Report of sound generation.
  6. Report of exhaust emissions showing compliance with applicable regulations.
  7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- G. Warranty: Special warranty specified in this Section.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
- D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- F. Comply with ASME B15.1.
- G. Comply with NFPA 37.
- H. Comply with NFPA 70.
- I. Comply with NFPA 99.
- J. Comply with NFPA 110 requirements for Level 2 emergency power supply system.
- K. Comply with UL 2200.
- L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

#### **1.6 PROJECT CONDITIONS**

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  - 1. Ambient Temperature: Minus 15 to plus 40 deg C.
  - 2. Relative Humidity: 0 to 95 percent.
  - 3. Altitude: Sea level to 1000 feet (300 m).

#### **1.7 COORDINATION**

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

#### **1.8 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

## **1.9 MAINTENANCE SERVICE**

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

## **1.10 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
  2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
  3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Generac Power Systems, Inc.
  2. Caterpillar; Engine Div.
  3. Onan/ Cummins.

### **2.2 ENGINE-GENERATOR SET**

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
  1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:
  1. Power Output Ratings: Nominal ratings as indicated.
  2. Output Connections: Three-phase, 4 wire.
  3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

## D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

## E. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
  - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

- a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

## **2.3 ENGINE**

- A. Fuel: Fuel oil, Grade DF-2.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: The following items are mounted on engine or skid:
  1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
  1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
  2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable isochronous, with speed sensing.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
  1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.

- b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump.
  - 1. Configuration: Vertical or Horizontal air discharge.
  - 2. Radiator Core Tubes: Aluminum.
  - 3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  - 4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  - 5. Fan.
  - 6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  - 7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- J. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
  - 1. Minimum sound attenuation of 25 dB at 500 Hz.
  - 2. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.
- K. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- L. Starting System: 24-V electric, with negative ground.
  - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
  - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
  - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
  - 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
  - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
  - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
  - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
  - 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

- a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
- b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
- c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

## **2.4 CONTROL AND MONITORING**

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level [1] [2] system, and the following:
  1. AC voltmeter.
  2. AC ammeter.
  3. AC frequency meter.
  4. DC voltmeter (alternator battery charging).
  5. Engine-coolant temperature gage.
  6. Engine lubricating-oil pressure gage.
  7. Running-time meter.
  8. Ammeter-voltmeter, phase-selector switch(es).



9. Generator-voltage adjusting rheostat.
  10. Fuel tank derangement alarm.
  11. Fuel tank high-level shutdown of fuel supply alarm.
  12. Generator overload.
- E. Indicating and Protective Devices and Controls:
1. AC voltmeter.
  2. AC ammeter.
  3. AC frequency meter.
  4. DC voltmeter (alternator battery charging).
  5. Engine-coolant temperature gage.
  6. Engine lubricating-oil pressure gage.
  7. Running-time meter.
  8. Ammeter-voltmeter, phase-selector switch(es).
  9. Generator-voltage adjusting rheostat.
  10. Start-stop switch.
  11. Overspeed shutdown device.
  12. Coolant high-temperature shutdown device.
  13. Coolant low-level shutdown device.
  14. Oil low-pressure shutdown device.
  15. Fuel tank derangement alarm.
  16. Fuel tank high-level shutdown of fuel supply alarm.
  17. Generator overload.
- F. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- G. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.
- H. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
1. Engine high-temperature shutdown.
  2. Lube-oil, low-pressure shutdown.
  3. Overspeed shutdown.
  4. Remote emergency-stop shutdown.
  5. Engine high-temperature prealarm.
  6. Lube-oil, low-pressure prealarm.
  7. Fuel tank, low-fuel level.
  8. Low coolant level.
- I. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated. Install remote annunciator in UPS room.

**2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION**

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
  - 1. Tripping Characteristic: Designed specifically for generator protection.
  - 2. Trip Rating: Matched to generator rating.
  - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
  - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

**2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR**

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Dripproof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
  - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12 percent, maximum.

**2.7 OUTDOOR GENERATOR-SET ENCLOSURE**

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to

components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
  - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
  - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- C. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

## **2.8 MOTORS**

- A. General requirements for motors are specified in Division 23.
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

## **2.9 VIBRATION ISOLATION DEVICES**

- A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## **2.10 FINISHES**

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## **2.11 SOURCE QUALITY CONTROL**

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
  1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  2. Full load run.
  3. Maximum power.
  4. Voltage regulation.
  5. Transient and steady-state governing.
  6. Single-step load pickup.
  7. Safety shutdown.
  8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
  9. Report factory test results within 10 days of completion of test.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases.
- D. Install Schedule 40, black steel piping with welded joints for cooling water piping between engine-generator set and heat exchanger. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
  1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black

steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Connect fuel piping to engines with a gate valve and union and flexible connector.
  - 1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Division 23 Section "Facility Fuel-Oil Tanks and Piping."
- F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

### **3.4 IDENTIFICATION**

- A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

### **3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. 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.
- C. 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.
- D. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test utilizing load banks.
  3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    - c. Verify acceptance of charge for each element of the battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
  5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
  7. Exhaust Emissions Test: Comply with applicable government test criteria.
  8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
  9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
  10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- E. Coordinate tests with tests for transfer switches and run them concurrently.
- F. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- G. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- J. Remove and replace malfunctioning units and retest as specified above.

- K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

### **3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1 Section "Demonstration and Training."

**END OF SECTION 26 3213**





**SECTION 26 3600**  
**TRANSFER SWITCHES**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes transfer switches rated 600 V and less, including the following:
  - 1. Automatic transfer switches.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- C. Qualification Data: For manufacturer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
  - 1. Features and operating sequences, both automatic and manual.
  - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

**1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

- C. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NEMA ICS 1.
- F. Comply with NFPA 70.
- G. Comply with NFPA 99.
- H. Comply with NFPA 110.
- I. Comply with UL 1008 unless requirements of these Specifications are stricter.

## **1.5 PROJECT CONDITIONS**

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.

## **1.6 COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Contactor Transfer Switches:
    - a. Generac Power Systems, Inc.
    - b. Caterpillar.
    - c. Onan/ Cummins.

### **2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS**

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
  - 2. Switch Action: Double throw; mechanically held in both directions.
  - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- H. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
  - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

- D. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
- H. Automatic Transfer-Switch Features:
  - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
  - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  - 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  - 5. Test Switch: Simulate normal-source failure.
  - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  - 9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
  - 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
  - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
  - b. Push-button programming control with digital display of settings.
  - c. Integral battery operation of time switch when normal control power is not available.

## **2.4 SOURCE QUALITY CONTROL**

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Floor-Mounting Switch: Anchor to floor by bolting.
  1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Identify components according to Division 26 Section "Identification for Electrical Systems."
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

### **3.2 CONNECTIONS**

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. 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.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
  2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - a. Check for electrical continuity of circuits and for short circuits.
    - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - c. Verify that manual transfer warnings are properly placed.
    - d. Perform manual transfer operation.
  5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    - c. Verify time-delay settings.
    - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- B. Testing Agency's Tests and Inspections:
1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - a. Check for electrical continuity of circuits and for short circuits.
    - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - c. Verify that manual transfer warnings are properly placed.
    - d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
  - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
  - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.

### **3.4 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

**END OF SECTION 26 3600**





**SECTION 26 4113****LIGHTNING PROTECTION FOR STRUCTURES****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 lightning protection for structures and fire protection water storage tank.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
  - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
  - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- C. Field quality-control reports.
- D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
  - 1. Ground rods.
  - 2. Ground loop conductor.

**1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.
- B. System Certificate:
  - 1. UL Master Label.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

**1.6 COORDINATION**

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

**PART 2 - PRODUCTS****2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS**

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. East Coast Lightning Equipment Inc.
    - b. ERICO International Corporation.
    - c. Harger.
    - d. Heary Bros. Lightning Protection Co. Inc.
    - e. Independent Protection Co.
    - f. Preferred Lightning Protection.
    - g. Robbins Lightning, Inc.
    - h. Thompson Lightning Protection, Inc.
  - 2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
  - 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.
- C. Main and Bonding Conductors: Aluminum.
- D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

- E. Ground Rods: Zinc-coated or Stainless steel.
- F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Stainless steel.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
  - 1. System conductors.
  - 2. Down conductors.
  - 3. Interior conductors.
  - 4. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.
- D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

#### **3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

#### **3.3 CORROSION PROTECTION**

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

#### **3.4 FIELD QUALITY CONTROL**

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Obtain a UL Master Label for system.

**END OF SECTION 26 4113**



**SECTION 26 4313****TRANSIENT VOLTAGE SUPPRESSION****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes field-mounted TVSS for low-voltage (120 to 600 V) power distribution and control equipment.

**1.2 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
- B. Field quality-control reports.
- C. Operation and maintenance data.
- D. Warranties: Sample of special warranties.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- C. Comply with NEMA LS 1.
- D. Comply with UL 1283 and UL 1449.
- E. Comply with NFPA 70.

**1.4 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS****2.1 SERVICE ENTRANCE SUPPRESSORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advanced Protection Technologies Inc. (APT).
  2. Current Technology Inc.; Danaher Power Solutions.
  3. Danaher Power Solutions; United Power Products.
  4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  6. Intermatic, Inc.
  7. Leviton Mfg. Company Inc.
  8. Liebert Corporation; a division of Emerson Network Power.
  9. Siemens Energy & Automation, Inc.
  10. Square D; a brand of Schneider Electric.
  11. Surge Suppression Incorporated.
- B. Surge Protection Devices:
1. Non-modular.
  2. LED indicator lights for power and protection status.
  3. Comply with UL 1449.
  4. Fuses, rated at 200-kA interrupting capacity.
  5. Fabrication using bolted compression lugs for internal wiring.
  6. Integral disconnect switch.
  7. Redundant suppression circuits.
  8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
  9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
  10. LED indicator lights for power and protection status.
- C. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
- D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
1. Line to Neutral: 70,000 A.
  2. Line to Ground: 70,000 A.
  3. Neutral to Ground: 50,000 A.
- E. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 800 V for 480/277 V.
  2. Line to Ground: 800 V for 480/277 V.
  3. Neutral to Ground: 800 V for 480/277 V.

**2.2 ENCLOSURES**

- A. Indoor Enclosures: NEMA 250 Type 1.

- B. Outdoor Enclosures: NEMA 250 Type 3R.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.
  - 1. Provide multiple, 30-A circuit breaker as a dedicated disconnecting means for TVSS unless otherwise indicated.

#### **3.2 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. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
  - 2. After installing TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.
  - 3. Complete startup checks according to manufacturer's written instructions.
- C. TVSS device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

#### **3.3 STARTUP SERVICE**

- A. Do not energize or connect service entrance equipment and panelboards to their sources until TVSS devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

#### **3.4 DEMONSTRATION**

- A. Train Owner's maintenance personnel to maintain TVSS devices.

**END OF SECTION 26 4313**





**SECTION 26 5100****INTERIOR LIGHTING****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Interior lighting fixtures, lamps, and ballasts.
  - 2. Exit signs.
  - 3. Lighting fixture supports.
- B. Related Sections:
  - 1. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
  - 2. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

**1.2 SUBMITTALS**

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- C. Field quality-control reports.

**1.3 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

**2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS**

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- H. Diffusers and Globes:
  - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
    - b. UV stabilized.
  - 2. Glass: Annealed crystal glass unless otherwise indicated.

**2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS**

- A. General Requirements for Electronic Ballasts:
  - 1. Comply with UL 935 and with ANSI C82.11.
  - 2. Designed for type and quantity of lamps served.
  - 3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
  - 4. Sound Rating: Class A.
  - 5. Total Harmonic Distortion Rating: Less than 10 percent.
  - 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  - 7. Operating Frequency: 42 kHz or higher.
  - 8. Lamp Current Crest Factor: 1.7 or less.
  - 9. BF: 0.88 or higher.
  - 10. Power Factor: 0.95 or higher.
- B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
- C. Electromagnetic Ballasts: Do not use electromagnetic ballasts.
  - 1. Ballast Manufacturer Certification: Indicated by label.

- D. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
- E. Ballasts for Low-Temperature Environments: Electronic type rated for 0 deg F starting and operating temperature with indicated lamp types.
- F. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
  - 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
  - 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
  - 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
  - 4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

## 2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
  - 1. Lamp end-of-life detection and shutdown circuit.
  - 2. Automatic lamp starting after lamp replacement.
  - 3. Sound Rating: Class A.
  - 4. Total Harmonic Distortion Rating: Less than 20 percent.
  - 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  - 6. Operating Frequency: 20 kHz or higher.
  - 7. Lamp Current Crest Factor: 1.7 or less.
  - 8. BF: 0.95 or higher unless otherwise indicated.
  - 9. Power Factor: 0.98, except fixtures designated as "Residential" may use low-power-factor electronic ballasts or higher.
  - 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.

## 2.5 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
  - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

- e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

## **2.6 FLUORESCENT LAMPS**

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches. 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.
- B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.
- C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.
  - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
  - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
  - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
  - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
  - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
  - 6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
  - 7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

## **2.7 LIGHTING FIXTURE SUPPORT COMPONENTS**

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.

## C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

## D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

## E. Adjust aimable lighting fixtures to provide required light intensities.

## F. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

**3.2 FIELD QUALITY CONTROL**

## A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

## B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

**END OF SECTION 26 5100**



**SECTION 26 5600**  
**EXTERIOR LIGHTING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
1. Exterior luminaires with lamps and ballasts.
  2. Luminaire-mounted photoelectric relays.
  3. Poles and accessories.

**1.2 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION**

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.
- C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
- D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
1. Basic wind speed for calculating wind load for poles exceeding 49.2 feet in height is 90 mph .
    - a. Wind Importance Factor: 1.0.
    - b. Minimum Design Life: 50 years.
    - c. Velocity Conversion Factors: 1.0.
  2. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph (40 m/s).
    - a. Wind Importance Factor: 1.0.
    - b. Minimum Design Life: 25 years.
    - c. Velocity Conversion Factors: 1.0.

**1.3 SUBMITTALS**

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

**1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2, "National Electrical Safety Code."
- C. Comply with NFPA 70.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

**2.2 GENERAL REQUIREMENTS FOR LUMINAIRES**

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.



- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
    - a. Color: Light bronze.
- O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - 1. Label shall include the following lamp and ballast characteristics:
    - a. "USES ONLY" and include specific lamp type.
    - b. Lamp configuration (4-eight bar), base type, and nominal wattage for luminaires.
    - c. CCT and CRI for all luminaires.

## **2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS**

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.[ Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.]
  - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
  - 2. Adjustable window slide for adjusting on-off set points.

**2.4 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS**

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
  - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
  - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
  - 3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all poles.
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

**2.5 STEEL POLES**

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig one-piece construction up to 40 feet in height with access handhole in pole wall.
  - 1. Shape: Round, tapered.
  - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  - 1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with galvanized-steel bolts.
  - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
  - 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

- E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.
- F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 16 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- H. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- I. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.
- J. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
  - 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
  - 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected by Architect from manufacturer's full range.

### **PART 3 - EXECUTION**

#### **3.1 LUMINAIRE INSTALLATION**

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

#### **3.2 POLE INSTALLATION**

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
  - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
  3. Trees: 15 feet from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
  2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
  3. Install base covers unless otherwise indicated.
  4. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.
- F. Raise and set poles using web fabric slings (not chain or cable).

### **3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES**

- A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

### **3.4 CORROSION PREVENTION**

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### **3.5 GROUNDING**

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole unless otherwise indicated.
  2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

**END OF SECTION 26 5600**

**SECTION 27 0528****PATHWAYS FOR COMMUNICATIONS SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Surface pathways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

**B. Related Requirements:**

1. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

**1.2 ACTION SUBMITTALS****A. Product Data:** For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.**B. LEED Submittals:**

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

**C. Shop Drawings:** For custom enclosures and cabinets.**PART 2 - PRODUCTS****2.1 METAL CONDUITS AND FITTINGS****A. General Requirements for Metal Conduits and Fittings:**

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

**B. GRC:** Comply with ANSI C80.1 and UL 6.**C. EMT:** Comply with ANSI C80.3 and UL 797.

- D. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Setscrew or compression.
  - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- E. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## **2.2 NONMETALLIC CONDUITS AND FITTINGS (FOR EXTERIOR USE ONLY)**

- A. General Requirements for Nonmetallic Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Continuous HDPE: Comply with UL 651B.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## **2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS**

- A. Description: Comply with UL 2024; flexible-type pathway, approved for riser installation unless otherwise indicated.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.

## **2.4 SURFACE PATHWAYS**

- A. General Requirements for Surface Pathways:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish.

**2.5 BOXES, ENCLOSURES, AND CABINETS**

- A. General Requirements for Boxes, Enclosures, and Cabinets:
  - 1. Comply with TIA-569-B.
  - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.
- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum galvanized with gasketed cover.
- G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- H. Gangable boxes are prohibited.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
  - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.
  - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING**

- A. General Requirements for Handholes and Boxes:
  - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. Comply with TIA-569-B.

- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 1. Standard: Comply with SCTE 77.
  - 2. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
  - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 5. Cover Legend: Molded lettering, "COMMUNICATIONS."
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete, reinforced concrete.
  - 1. Standard: Comply with SCTE 77.
  - 2. Color of Frame and Cover: Gray.
  - 3. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
  - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 6. Cover Legend: Molded lettering, "COMMUNICATIONS."

### **PART 3 - EXECUTION**

#### **3.1 PATHWAY APPLICATION**

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC.
  - 2. Concealed Conduit, Aboveground: GRC, EMT.
  - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
  - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
  - 3. Exposed and Subject to Severe Physical Damage: GRC.
  - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 5. Damp or Wet Locations: GRC.
  - 6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
  - 7. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
  - 1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  - 2. EMT: Use setscrew or compression, cast-metal fittings. Comply with NEMA FB 2.10.



- E. Install surface pathways only where indicated on Drawings.

### 3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Pathways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
  - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
  - 3. Arrange pathways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
  - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- H. Stub-ups to Above Recessed Ceilings:
  - 1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- J. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- K. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- M. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use.

- N. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
- O. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:
1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
  2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
  3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.
- P. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.
- Q. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service pathway enters a building or structure.
  3. Where otherwise required by NFPA 70.
- R. Expansion-Joint Fittings:
1. Install in each run of aboveground and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- S. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- T. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

**3.3 INSTALLATION OF UNDERGROUND CONDUIT****A. Direct-Buried Conduit:**

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

**3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES**

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- C. Install handholes with bottom below frost line, below grade.
- D. Field cut openings for conduits according to enclosure manufacturer's written instructions.

**3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS**

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

**3.6 FIRESTOPPING**

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

**3.7 PROTECTION**

- A. Protect coatings, finishes, and cabinets from damage or deterioration.

**END OF SECTION 27 0528**



**SECTION 270800****COMMUNICATION SYSTEMS COMMISSIONING****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The purpose of this section is to specify Division 27 responsibilities in the commissioning process which are being directed by the Commissioning Authority (CxA). Other communication systems testing may be required under the direction of the Construction Manager (CM).
- B. The list of commissioned equipment and systems is found in Section 3.9.
- C. Commissioning requires the participation of Division 27 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 017500. Division 27 shall be familiar with all parts of Section 017500 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

**1.2 DEFINITIONS**

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

**1.3 INFORMATION SUBMITTALS**

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

**1.4 RESPONSIBILITIES**

- A. Div. 27 Contractors: The commissioning responsibilities applicable to the communications contractor are as follows (all references apply to commissioned equipment):
  - 1. Construction and Acceptance Phases
    - a. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the commissioning process.
    - b. Contractors shall provide normal cut sheets and shop drawing submittals to the CxA of commissioned equipment.
    - c. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of startup and functional testing procedures.
      - 1) Typically this will include detailed manufacturer installation and startup, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, and full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
      - 2) The CxA may request further documentation necessary for the commissioning process.

- 3) This data request may be made prior to normal submittals.
  - d. Provide a copy of the O&M manual submittals of commissioned equipment, through normal channels, for the CxA for review.
  - e. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, drawings or equipment documentation is not sufficient for writing detailed testing procedures.
  - f. Provide assistance to the CxA in preparation of the specific functional performance test procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
  - g. Develop a full startup and initial checkout plan using manufacturer's startup procedures and the pre-functional checklists from the CxA. Submit manufacturer's detailed startup procedures and the full startup plan and procedures and other requested equipment documentation to CxA for review.
  - h. During the startup and initial checkout process, execute and document the communications related portions of the pre-functional checklists provided by the CxA for all commissioned equipment.
  - i. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
  - j. Address current A/E punch list items before functional testing.
  - k. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
  - l. Perform functional performance testing under the direction of the CxA for specified equipment in 017500. Assist the CxA in interpreting the monitoring data, as necessary.
  - m. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC, CM and A/E and retest the equipment.
  - n. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
  - o. During construction, maintain as-built red-line drawings for all drawings and final CAD as-built for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.
  - p. Provide training of the Owner's operating personnel as specified.
  - q. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
2. Warranty Period
    - a. Execute deferred functional performance testing, witnessed by the CxA, according to the specifications.
    - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

## 1.5 COMMISSIONING DOCUMENTATION

- A. Contractor to provide the following information to the CxA for inclusion in the commissioning plan:
  1. Plan for delivery and review of submittals, systems manuals, and other documents and reports
  2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  3. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
  4. Test and inspection reports and certificates.

5. Corrective action documents.

## **1.6 RELATED WORK**

- A. Refer to Section 017500 for a listing of all sections where commissioning requirements are found.
- B. Refer to Section 017500 for systems to be commissioned and functional testing requirements.
- C. Coordinate all provisions and installations of Div. 27 with the hardware schedule indicated on the Architectural drawings.

## **PART 2 - PRODUCTS**

### **2.1 TEST EQUIPMENT**

- A. Division 27 shall provide all test equipment necessary to fulfill the testing requirements of this Division.
- B. Refer to Section 017500 for additional Division 27 requirements.

## **PART 3 - EXECUTION**

### **3.1 SUBMITTALS**

- A. Division 27 shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 017500 for additional Division 27 requirements.

### **3.2 STARTUP AND PRE-FUNCTIONAL PROCEDURES**

- A. The communications contractor shall follow the startup and initial checkout procedures listed in the Responsibilities list in this section and in 017500. Division 27 has startup responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and CM. Beginning system testing before full completion does not relieve the Contractor of responsibility for fully completing the system, including all pre-functional checklists as soon as possible.

### **3.3 GENERAL TESTING REQUIREMENTS**

- A. Cable Testing – General:
  - a. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
  - b. Where post-manufacture test data has been provided by the manufacturer on the reel or shipping carton, submit copies to the CxA and Owner as part of the cable test results.
  - c. The CxA reserves the right to observe any or all portions of the cable testing process. Notify the CxA within seven days of testing.
  - d. The CxA reserves the right to conduct, using the contractor's equipment and labor, a random re-test of up to twenty percent (20%) of the cable plant to confirm documented test results.

- e. Test results and corrective procedures are to be documented and submitted to the CxA within five (5) working days of test completion. If these are not submitted within the given time, the test results will be considered void and must be resubmitted to the CxA.
- f. Provide the CxA with as-built drawings
- g. Provide the CxA with any cable and link testing documentation required by other Sections for concurrent review with the EOR and for inclusion in the final commissioning report.

### **3.4 FUNCTIONAL PERFORMANCE TESTS**

- B. Refer to Section 3.9 for a list of systems to be commissioned.

### **3.5 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS**

- A. Refer to Section 017500 for specific details on non-conformance issues relating to pre-functional checklists and tests.
- B. Refer to Section 017500 for issues relating to functional performance tests.

### **3.6 OPERATIONS AND MAINTENANCE (O&M) MANUALS**

- A. Division 27 shall compile and prepare documentation for all equipment and systems covered in Division 27 and deliver to the CM or GC for inclusion in the O&M manuals, according to Sections 013300 and 017700.
- B. The CxA shall receive a copy of the O&M manuals for concurrent review.

### **3.7 TRAINING OF OWNER PERSONNEL**

- A. The CM or GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 017500 for additional details.
- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 017500 for additional details.
- C. Communications Contractor: The Div. 27 contractor shall have the following training responsibilities:
  - 1. Provide the CxA with a training plan eight (8) weeks before the planned training according to the outline described in Section 017500.
  - 2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned communications equipment or system.
  - 3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation.
  - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - 5. The appropriate trade or manufacturer's representative shall provide the instructions on each piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
  - 6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  - 7. Training shall include:
    - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.



- b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible and any emergency procedures.
  - c. Discuss relevant health and safety issues and concerns.
  - d. Discuss warranties and guarantees.
  - e. Cover common troubleshooting problems and solutions.
  - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
  - g. Discuss any peculiarities of equipment installation or operation.
  - h. The format and training agenda in Guidelines for Commissioning HVAC Systems, ASHRAE, Guideline 0-2005 is recommended.
  - i. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as appropriate.
- 8. Hands-on training shall include operation of equipment in all modes possible.
  - 9. .
  - 10. Training shall occur after functional testing is complete, unless approved otherwise by the CM or GC and Owner.

### **3.8 DEFERRED TESTING (NOT USED)**

### **3.9 WRITTEN WORK PRODUCTS**

- A. Written work products of Contractors will consist of the startup and initial checkout plan described in Section 017500 and the filled out startup, initial checkout and pre-functional checklists.

### **3.10 EQUIPMENT AND ASSOCIATED SYSTEMS TO BE COMMISSIONED**

<b>SPEC. SECTION</b>	<b>SYSTEM DESCRIPTION</b>	<b>SAMPLING</b>
272000	Communications Data Network	20%
273000	Voice Communications	20%
275123	Intercommunications and Program Systems	100%
275300	Distributed System (CATV)	20%
275313	Wireless Clock and Tone Generator System	20%
275319	Clock Systems	20%

Note: Provide separate checklist for each unit. Complete prior to functional testing. Pre-functional checklist sampling is not acceptable.

**END OF SECTION 270800**



**SECTION 27 1100****COMMUNICATIONS EQUIPMENT ROOM FITTINGS****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Telecommunications mounting elements.
  - 2. Backboards.
  - 3. Telecommunications equipment racks and cabinets.
  - 4. Grounding.
- B. Related Requirements:
  - 1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
  - 2. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

**1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
  - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

**1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD/NTS.
  - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

## **PART 2 - PRODUCTS**

### **2.1 BACKBOARDS**

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by length as shown on the drawings.

### **2.2 EQUIPMENT FRAMES**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. ADC.
2. Belden Inc.
3. Cooper B-Line.
4. Emerson Network Power Connectivity Solutions.
5. Hubbell Premise Wiring.
6. Leviton Commercial Networks Division.
7. Middle Atlantic Products, Inc.
8. Ortronics, Inc.
9. Panduit Corp.
10. Siemon Co. (The).
11. Tyco Electronics Corporation; AMP Products.

- B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

- C. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.
4. Screened ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. Roof-mounted, 550-cfm (260-L/s) fan with filter.
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.

- D. Modular Wall Cabinets:

1. Wall mounting.
2. Steel or aluminum construction.

3. Treated to resist corrosion.
4. Lockable front doors.
5. Louvered side panels.
6. Cable access provisions top and bottom.
7. Grounding lug.
8. Roof-mounted, 250-cfm (118-L/s) fan.
9. Power strip.
10. All cabinets keyed alike.

E. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

## 2.3 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Telecommunications Main Bus Bar:
1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
  2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
  3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
- C. Comply with J-STD-607-A.

## 2.4 LABELING

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## PART 3 - EXECUTION

### 3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

**3.2 INSTALLATION**

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
  - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
  - 2. Record agreements reached in meetings and distribute them to other participants.
  - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
  - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

**3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

**3.4 FIRESTOPPING**

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

**3.5 GROUNDING**

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
  - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.
- E. Upon completion of the installation of the data/telecommunication grounding system, the Contractor shall perform approved standard ground resistance tests with an Associate approved ground resistance test unit (i.e. stakeless clamp-on ground resistance tester, two-point and three-point fall of potential tester), using approved procedures as noted in this specification.
- F. The Contractor shall demonstrate by testing that the data/telecommunication grounding system to earth resistance value is 5 Ohms or less, utilizing a ~~%~~ clamp-on or 3 point fall of potential tester.

### **3.6 IDENTIFICATION**

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
- B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Labels shall be preprinted or computer-printed type.

**END OF SECTION 27 1100**





**SECTION 27 1300****COMMUNICATIONS BACKBONE CABLING****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Pathways.
  - 2. UTP cable.
  - 3. Cable connecting hardware, patch panels, and cross-connects.
  - 4. Cabling identification products.

**1.2 BACKBONE CABLING DESCRIPTION**

- A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

**1.3 PERFORMANCE REQUIREMENTS**

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
  - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
  - 2. Cabling administration drawings and printouts.
  - 3. Wiring diagrams to show typical wiring schematics including the following:
    - a. Cross-connects.
    - b. Patch panels.
    - c. Patch cords.
  - 4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

5. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.

## **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance data.

## **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
  2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be present at all times when Work of this Section is performed at Project site.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- E. Grounding: Comply with ANSI-J-STD-607-A.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

**PART 2 - PRODUCTS****2.1 PATHWAYS**

- A. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
1. Support brackets with cable tie slots for fastening cable ties to brackets.
  2. Lacing bars, spools, J-hooks, and D-rings.
  3. Straps and other devices.
- B. Cable Trays:
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. Cable Management Solutions, Inc.
    - b. Cablofil Inc.
    - c. Cooper B-Line, Inc.
    - d. Cope - Tyco/Allied Tube & Conduit.
    - e. GS Metals Corp.
  2. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inches (0.012 mm) thick.
    - a. Basket Cable Trays: 12 inches wide and 2 inches deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
- C. Conduit and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems." **Flexible metal conduit shall not be used.**
1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

**2.2 BACKBOARDS**

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

**2.3 UTP CABLE**

- 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. Belden CDT Inc.; Electronics Division.
  2. Berk-Tek; a Nexans company.
  3. CommScope, Inc.
  4. Draka USA.
  5. Genesis Cable Products; Honeywell International, Inc.
  6. KRONE Incorporated.

7. Mohawk; a division of Belden CDT.
  8. Nordex/CDT; a subsidiary of Cable Design Technologies.
  9. Superior Essex Inc.
  10. SYSTIMAX Solutions; a CommScope Inc. brand.
  11. 3M.
  12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
- B. Description: 100-ohm, 50-pair UTP, formed into 25-pair binder groups covered with a **gray** thermoplastic jacket **and overall metallic shield**.
1. Comply with ICEA S-90-661 for mechanical properties.
  2. Comply with TIA/EIA-568-B.1 for performance specifications.
  3. Comply with TIA/EIA-568-B.2, Category 6.
  4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, General Purpose: Type CM or CMG.
    - b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    - c. Communications, Riser Rated: Type CMR, complying with UL 1666.
    - d. Communications, Limited Purpose: Type CMX.
    - e. Multipurpose: Type MP or MPG.
    - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    - g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

## 2.4 UTP CABLE HARDWARE

- 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 Technology Systems Industries, Inc.
  2. Dynacom Corporation.
  3. Hubbell Premise Wiring.
  4. KRONE Incorporated.
  5. Leviton Voice & Data Division.
  6. Molex Premise Networks; a division of Molex, Inc.
  7. Nordex/CDT; a subsidiary of Cable Design Technologies.
  8. Panduit Corp.
  9. Siemon Co. (The).
  10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus **25** percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.

- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
  - 1. Number of Jacks per Field: One for each four-pair UTP cable indicated.
- F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- G. Patch Cords: Factory-made, 4-pair cables in 48-inch (1200-mm) lengths; terminated with 8-position modular plug at each end.
  - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
  - 2. Patch cords shall have color-coded boots for circuit identification.

## **2.5 GROUNDING**

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

## **2.6 IDENTIFICATION PRODUCTS**

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## **2.7 SOURCE QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

## **PART 3 - EXECUTION**

### **3.1 ENTRANCE FACILITIES**

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

**3.2 WIRING METHODS**

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics. Conceal raceway and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

**3.3 INSTALLATION OF PATHWAYS**

- A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.
- B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.
- C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- D. Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- E. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- F. Pathway Installation in Communications Equipment Rooms:
  - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
  - 2. Install cable trays to route cables if conduits cannot be located in these positions.
  - 3. Secure conduits to backboard when entering room from overhead.
  - 4. Extend conduits 3 inches (76 mm) above finished floor.
  - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

**3.4 INSTALLATION OF CABLES**

- A. Comply with NECA 1.
- B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables shall not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
12. Cable bundles shall be installed carefully. Cables inside the bundle can be damaged easily as cables on the outside. Examine bundles to ensure that their weight is not causing additional compression on the cable jackets.
13. No UTP cable shall have any splices or repair of damaged insulation.
14. No UTP cable shall exceed the distance of 295 feet (90 meters) from the service drop wiring closet, as stated in the EIA/TIA 568 document regarding horizontal wiring.
15. All cabling installed in the riser and horizontal distribution shall meet or exceed all local fire codes.
16. The Contractor will be responsible for cleanup of all facilities and buildings related to the cabling system installation project, during and at completion. The work site and adjacent area should be left in the same condition or cleaner than when starting a shift. This shall be done on a daily basis.
17. The Contractor should protect building equipment, exterior and interior, in the immediate and adjacent work areas. The Contractor should protect building finishes and services not affected by the modifications.
18. Utilize bridle eye type cable supports for all cable runs not installed in raceway or cable tray system. ~~%~~+hooks are not permitted.
19. Contractor shall provide all plywood backboards indicated to be installed for voice and data wiring. Backboards shall be  $\frac{3}{4}$ "-void free plywood painted with two (2) coats of fire retardant paint, color to match wall finish. Size and quantity of plywood backboards shall be noted on drawings.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
  3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
  4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
  5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
  6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).
- H. Cable Terminations
1. All voice cabling will be terminated at the MDF/IDF using #10 hardware and at the information outlet on RJ-45 Category 5E or 6E outlets.
  2. All data cabling will be terminated in the telecom closet on Category 6E patch panels and at the information outlet on RJ-45 Category 6E outlets.
  3. All cabling installed in the riser and horizontal distribution shall meet or exceed all local fire codes.



**3.5 FIRESTOPPING**

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

**3.6 GROUNDING**

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

**3.7 IDENTIFICATION**

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Administration Class: 1.
  - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.
- D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- F. Cable and Wire Identification:
  - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  - a. Individually number wiring conductors that are connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
  - b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Each cable run will be labeled at both ends with corresponding drop number. Labeling shall be with snap-on wire markers as manufactured by LEM.
7. All cable outlets and termination panels/bays or blocks will be appropriately labeled to match the cable using the following labeling scheme:
  - Room number
  - (dash)
  - Face plate number
  - D or V (for data or voice)
  - CATV equipment and outlets
  - Conduit and cable system
  - All IT equipment enclosures including Fiber optic
  - Coupled bonding conductors
  - Paging and access control systems
  - Outlet number on the plate in sequence

Example 150-2D3 would represent the third data outlet on the second plate in Room 150.

- G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

### **3.8 FIELD QUALITY CONTROL**

- A. Tests and Inspections:

1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

- a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- D. Prepare test and inspection reports.

**END OF SECTION 27 1300**



**SECTION 27 1500****COMMUNICATIONS HORIZONTAL CABLING****PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. UTP cabling.
2. Multiuser telecommunications outlet assemblies.
3. Cable connecting hardware, patch panels, and cross-connects.
4. Telecommunications outlet/connectors.
5. Cabling system identification products.

**B. Related Requirements:**

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

**1.2 ADMINISTRATIVE REQUIREMENTS**

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

**1.3 ACTION SUBMITTALS****A. Product Data:** For each type of product.**B. Shop Drawings:**

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
2. Wiring diagrams to show typical wiring schematics, including the following:
  - a. Cross-connects.
  - b. Patch panels.
  - c. Patch cords.
3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

**1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance data.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
  - 2. Installation Supervision: Installation shall be under the direct supervision of RCDD, who shall be present at all times when Work of this Section is performed at Project site.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Test cables upon receipt at Project site. Test each pair of UTP cable for open and short circuits.

**PART 2 - PRODUCTS****2.1 HORIZONTAL CABLING DESCRIPTION**

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
  - 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
  - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
  - 3. Bridged taps and splices shall not be installed in the horizontal cabling.

**2.2 PERFORMANCE REQUIREMENTS**

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

### 2.3 UTP CABLE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. ADC.
  2. Belden Inc.
  3. Berk-Tek; a Nexans company.
  4. CommScope, Inc.
  5. Draka Cableteq USA.
  6. Genesis Cable Products; Honeywell International, Inc.
  7. Mohawk; a division of Belden Networking, Inc.
  8. Superior Essex Inc.
  9. SYSTIMAX Solutions; a CommScope, Inc. brand.
  10. 3M Communication Markets Division.
  11. Tyco Electronics Corporation; AMP Products.
- B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
  2. Comply with TIA/EIA-568-B.1 for performance specifications.
  3. Comply with TIA/EIA-568-B.2, **Category 6**.
  4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, General Purpose: Type CM or CMG.
    - b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    - c. Communications, Riser Rated: Type CMR, complying with UL 1666.
    - d. Communications, Limited Purpose: Type CMX.
    - e. Multipurpose: Type MP or MPG.
    - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
    - g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

### 2.4 UTP CABLE HARDWARE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. ADC.
  2. American Technology Systems Industries, Inc.
  3. Belden Inc.
  4. Dynacom Inc.
  5. Hubbell Premise Wiring.
  6. Leviton Commercial Networks Division.

7. Molex Premise Networks; a division of Molex, Inc.
  8. Panduit Corp.
  9. Simon Co. (The).
  10. Tyco Electronics Corporation; AMP Products.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One for each four-pair UTP cable indicated.
- F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- G. Patch Cords: Factory-made, four-pair cables in 48-inch1200-mm lengths; terminated with eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
  2. Patch cords shall have color-coded boots for circuit identification.

## 2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Four-port-connector assemblies mounted in single faceplate.
1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
  2. For use with snap-in jacks accommodating any combination of UTP work area cords.
  3. Legend: Machine printed, in the field, using adhesive-tape label.

## 2.6 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.



**2.7 IDENTIFICATION PRODUCTS**

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

**2.8 SOURCE QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

**PART 3 - EXECUTION****3.1 ENTRANCE FACILITIES**

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

**3.2 WIRING METHODS**

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
  - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
  - 2. Install lacing bars and distribution spools.
  - 3. Install conductors parallel with or at right angles to sides and back of enclosure.

**3.3 INSTALLATION OF CABLES**

- A. Comply with NECA 1.
- B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables shall not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

- a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
  - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

### **3.4 FIRESTOPPING**

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### **3.5 GROUNDING**

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

### **3.6 IDENTIFICATION**

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  1. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

- C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
- E. Cable and Wire Identification:
  - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
  - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
  - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    - b. Label each unit and field within distribution racks and frames.
  - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
  - 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
- F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
  - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

### **3.7 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
  - 2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
  - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
  - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
5. UTP Performance Tests:
  - a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
    - 1) Wire map.
    - 2) Length (physical vs. electrical, and length requirements).
    - 3) Insertion loss.
    - 4) Near-end crosstalk (NEXT) loss.
    - 5) Power sum near-end crosstalk (PSNEXT) loss.
    - 6) Equal-level far-end crosstalk (ELFEXT).
    - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
    - 8) Return loss.
    - 9) Propagation delay.
    - 10) Delay skew.
6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
  - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
  - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

**END OF SECTION 27 1500**



**SECTION 280800****ELECTRONIC SAFETY AND SECURITY COMMISSIONING****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The purpose of this Section is to specify Division 28 responsibilities in the commissioning process which are being directed by the Commissioning Authority (CxA). Other Fire Alarm systems testing may be required under the direction of the Construction Manager (CM) and contract documents.
- B. Commissioning requires the participation of Division 28 Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents.
- C. The contractor shall execute all commissioning responsibilities assigned to them described in Section 01 75 00 "General Commissioning Requirements", the Contract Documents, and in the Commissioning Plan issued by the CxA.

**1.2 DEFINITIONS**

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

**1.3 INFORMATIONAL SUBMITTALS**

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

**1.4 RESPONSIBILITIES**

- A. Fire Alarm Contractor: The commissioning responsibilities applicable to the Division 28 contractor are as follows (all references apply to commissioned equipment):
  - 1. Construction and Acceptance Phases
    - a. Attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the commissioning process.
    - b. Contractors shall provide product data and shop drawing submittals to the CxA for commissioned equipment during normal submittal procedures.
    - c. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of startup and functional testing procedures
      - 1) Typically this will include detailed manufacturer installation and startup, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, and full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA
      - 2) The CxA may request further documentation necessary for the commissioning process
      - 3) This data request may be made prior to normal submittals

- d. Provide a copy of the O&M manual submittals of commissioned equipment, through normal channels, for the CxA for review
  - e. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, drawings or equipment documentation is not sufficient for writing detailed testing procedures.
  - f. Provide assistance to the CxA in preparation of the specific functional performance test procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
  - g. Develop a full startup and initial checkout plan using manufacturer's startup procedures and the pre-functional checklists from the CxA. Submit manufacturer's detailed startup procedures and the full startup plan and procedures and other requested equipment documentation to CxA for review.
  - h. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
  - i. Address current A/E punch list items before functional testing.
  - j. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
  - k. Perform functional performance testing under the direction of the CxA for specified equipment in Section 017500 and Section 3.9. Assist the CxA in interpreting the monitoring data, as necessary.
  - l. Notify the CxA within ten days of any AHJ testing procedures required by the Contract Documents. The CxA reserves the right to attend any third part testing at their discretion.
  - m. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, GC, CM and A/E and retest the equipment.
  - n. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
  - o. During construction, maintain as-built red-line drawings for all drawings and final CAD as-built for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.
  - p. Provide training of the Owner's operating personnel as specified.
  - q. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  - r. Participate in orientation and inspection for Division 28 systems, assemblies, equipment, and component maintenance as directed by the CxA.
  - s. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
2. Warranty Period
- a. Execute deferred functional performance testing, witnessed by the CxA, according to the specifications
  - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing

## 1.5 COMMISSIONING DOCUMENTATION

- A. Contractor to provide the following information to the CxA for inclusion in the commissioning plan:
- 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.



2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Division 28 systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that Division 28 systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.

#### **1.6 RELATED WORK**

- A. Refer to Section 017500 for a listing of all sections where commissioning requirements are found.

### **PART 2 - PRODUCTS**

#### **2.1 TEST EQUIPMENT**

- A. Division 28 shall provide all test equipment necessary to fulfill the testing requirements of this Division.
- B. Refer to Section 017500 for additional Division 28 requirements.

### **PART 3 - EXECUTION**

#### **3.1 SUBMITTALS**

- A. Division 28 shall provide submittal documentation relative to commissioning to the CxA as requested by the CxA. Refer to Section 017500 for additional Division 28 requirements

#### **3.2 STARTUP AND PRE-FUNCTIONAL PROCEDURES**

- A. The Mechanical contractors shall follow the startup and initial checkout procedures listed in the Responsibilities list in this section and in 017500. Division 28 has startup responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the commissioning agent or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CxA and CM. Beginning system testing before full completion does not relieve the Contractor of responsibility for fully completing the system, including all pre-functional checklists as soon as possible.
- C. Similar checklists will be developed by the CxA for all other equipment to be commissioned as listed in Section 017500
- D. Certify that Fire Alarm systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

- E. Certify that Fire Alarm instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- F. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- G. Inspect and verify the position of each device and interlock identified on checklists.
- H. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- I. Testing Instrumentation: Provide and install measuring instruments and logging devices to record test data as directed by the CxA.
- J. Prior to Functional Testing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- K. Notify the CxA within ten (10) days of any third party or AHJ inspections.
- L. The CxA along with the Division 28 Contractor shall prepare detailed testing plans, procedures, and checklists for Fire Alarm systems, subsystems, and equipment.

### **3.3 FUNCTIONAL PERFORMANCE TESTS**

- A. Refer to Section 3.9 for a list of systems to be commissioned.
- B. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- C. Scope of Fire Alarm testing shall include entire Fire Alarm installation and other associated systems which are required for full functionality of the system. Testing shall include measuring capacities and effectiveness of operational and control functions.
- D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the Fire Alarm system, document the deficiency and report it to the Owner and CxA. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

**3.4 TESTING DOCUMENTATION, NON-CONFORMANCE, AND APPROVALS**

- A. Refer to Section 017500 for specific details on non-conformance issues relating to pre-functional checklists and tests.
- B. Refer to Section 017500 for issues relating to functional performance tests.

**3.5 OPERATION AND MAINTENANCE MANUALS (O&M) MANUALS**

- A. Division 28 shall compile and prepare documentation for all equipment and systems covered in Division 28 and deliver to the CM or GC for inclusion in the O&M manuals, according to Sections 013300 and 017700.
- B. The CxA shall receive a copy of the O&M manuals for concurrent review.

**3.6 TRAINING OF OWNER PERSONNEL**

- A. The CM shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 017500 for additional details.
- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 017500 for additional details.
- C. Provide the CxA with a training plan eight (8) weeks before the planned training according to the outline described in Section 017500.
- D. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned equipment or system.
- E. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
- F. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
- G. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
- H. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
- I. Training shall include:
  - 1. Use the printed installation, operation and maintenance instruction material included in the O&M manuals
  - 2. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory

- suggestions. The training shall include startup, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
3. Discuss relevant health and safety issues and concerns.
  4. Discuss warranties and guarantees.
  5. Cover common troubleshooting problems and solutions.
  6. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
  7. Discuss any peculiarities of equipment installation or operation.
  8. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as appropriate.
- J. Hands-on training shall include startup and operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.
- K. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- L. Training shall occur after functional testing is complete, unless approved otherwise by the CM, Owner, and CxA.

### **3.7 DEFERRED TESTING**

- A. Refer to Section 017500 for requirements of deferred testing.

### **3.8 WRITTEN WORK PRODUCTS**

- A. Written work products of Contractors will consist of the startup and initial checkout plan described in Section 017500 and the filled out startup, initial checkout and pre-functional checklists.

### **3.9 EQUIPMENT AND ASSOCIATED SYSTEMS TO BE COMMISSIONED**

<b>SECTION</b>	<b>SYSTEM DESCRIPTION</b>	<b>SAMPLING</b>
28 13 00	Security and Communications System	100%
28 16 00	Intrusion Detection (and Alarm)	100%
28 23 00	Video Surveillance	100%
28 31 11	Digital Addressable Fire Alarm System	100%

**END OF SECTION 280800**

**SECTION 28 3111****DIGITAL, ADDRESSABLE 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 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Fire-alarm control unit.
  - 2. Manual fire-alarm boxes.
  - 3. System smoke detectors.
  - 4. Notification appliances.
  - 5. Magnetic door holders.
  - 6. Remote annunciator.
  - 7. Addressable interface device.
  - 8. Digital alarm communicator transmitter.
  - 9. System printer.

**1.3 DEFINITIONS**

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

**1.4 SYSTEM DESCRIPTION**

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

**1.5 SUBMITTALS**

- A. General Submittal Requirements:
  - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
  - 2. Shop Drawings shall be prepared by persons with the following qualifications:
    - a. Trained and certified by manufacturer in fire-alarm system design.
    - b. NICET-certified fire-alarm technician, Level III minimum.
- B. Product Data: For each type of product indicated.

- C. Shop Drawings: For fire-alarm system. Include floor plans, elevations, sections, details, and attachments to other work.
1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
  2. Include voltage drop calculations for notification appliance circuits.
  3. Include battery-size calculations.
  4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
  5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
  6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- D. Qualification Data: For qualified Installer.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in 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.
  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 fire-alarm control unit.
  7. Copy of NFPA 25.
- G. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
  2. Program Software Backup: On magnetic media or compact disk, complete with data files.
  3. Device address list.
  4. Printout of software application and graphic screens.

**1.6 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. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

**1.7 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10.
  - 2. Lamps for Strobe Units: Quantity equal to 10.
  - 3. Smoke Detectors, Fire Detectors: Quantity equal to 5.
  - 4. Detector Bases: Quantity equal to 2.
  - 5. Keys and Tools: One extra set for access to locked and tamperproofed components.
  - 6. Audible and Visual Notification Appliances: One of each type installed.
  - 7. Fuses: Two of each type installed in the system.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Faraday; Siemens Building Technologies, Inc.
  - 2. Federal Signal Corporation.
  - 3. Fire Control Instruments, Inc.; a Honeywell company.
  - 4. Fire Lite Alarms; a Honeywell company.
  - 5. Gamewell; a Honeywell company.
  - 6. GE Infrastructure; a unit of General Electric Company.
  - 7. NOTIFIER; a Honeywell company.
  - 8. Siemens Building Technologies, Inc.; Fire Safety Division.
  - 9. Silent Knight; a Honeywell company.
  - 10. SimplexGrinnell LP; a Tyco International company.

**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. Verified automatic alarm operation of smoke detectors.

5. Automatic sprinkler system water flow.
  6. Fire-extinguishing system operation.
  7. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
  2. Identify alarm 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. Close smoke dampers in air ducts of designated air-conditioning duct systems.
  8. Activate emergency shutoffs for gas and fuel supplies.
  9. Record events in the system memory.
  10. Record events by the system printer.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
  2. Low-air-pressure switch of a dry-pipe sprinkler system.
- 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 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.
  9. Low-air-pressure switch operation on a dry-pipe system.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

## **2.3 FIRE-ALARM CONTROL UNIT**

- A. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
    - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
    - b. Include a real-time clock for time annotation of events on the event recorder and printer.
  2. Addressable initiation devices that communicate device identity and status.



- a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
  - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
  1. Annunciator and Display: Liquid-crystal type, 2 line(s) of 40 characters, minimum.
  2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Circuits:
  1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
    - a. Initiating Device Circuits: Style B.
    - b. Notification Appliance Circuits: Style Y.
    - c. Signaling Line Circuits: Style 4.
    - d. Install no more than 50 addressable devices on each signaling line circuit.
  2. Serial Interfaces: Two RS-232 ports for printers.
- D. Smoke-Alarm Verification:
  1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
  2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
  3. Record events by the system printer.
  4. Sound general alarm if the alarm is verified.
  5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- E. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- H. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands

initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

- I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
  - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
  - 1. Batteries: Sealed lead calcium.
- K. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

## **2.4 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.
  - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  - 2. Station Reset: Key- or wrench-operated switch.
  - 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

## **2.5 SYSTEM SMOKE DETECTORS**

- A. General Requirements for System Smoke Detectors:
  - 1. Comply with UL 268; operating at 24-V dc, nominal.
  - 2. Detectors shall be two-wire type.
  - 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  - 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  - 5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
  - 6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
    - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.

- b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
    - c. Provide multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.).
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.).
  - 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
  - 4. Each sensor shall have multiple levels of detection sensitivity.
  - 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
  - 6. Relay Fan Shutdown: 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.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

- C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
  - 1. Mounting: Wall mounted unless otherwise indicated.
  - 2. Flashing shall be in a temporal pattern, synchronized with other units.
  - 3. Strobe Leads: Factory connected to screw terminals.
  - 4. Mounting Faceplate: Factory finished, red.

## **2.7 MAGNETIC DOOR HOLDERS**

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  - 1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
  - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  - 3. Rating: 24-V ac or dc.
- B. Material and Finish: Match door hardware.

## **2.8 REMOTE ANNUNCIATOR**

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
  - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
  - 2. Provide graphic annunciator. See drawings for details.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

## **2.9 ADDRESSABLE INTERFACE DEVICE**

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

## **2.10 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. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone

service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
  - 1. Programming device.
  - 2. LED display.
  - 3. Manual test report function and manual transmission clear indication.
  - 4. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
  - 1. Address of the alarm-initiating device.
  - 2. Address of the supervisory signal.
  - 3. Address of the trouble-initiating device.
  - 4. Loss of ac supply or loss of power.
  - 5. Low battery.
  - 6. Abnormal test signal.
  - 7. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

## **2.11 SYSTEM PRINTER**

- A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

## **PART 3 - EXECUTION**

### **3.1 EQUIPMENT INSTALLATION**

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- C. Smoke- or Heat-Detector Spacing:
  - 1. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
  - 2. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- E. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

- F. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling or 80+above finished floor, whichever is lower.
- H. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- I. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- J. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

### **3.2 CONNECTIONS**

- A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
  - 2. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
  - 3. Supervisory connections at valve supervisory switches.

### **3.3 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."
- B. Install framed instructions in a location visible from fire-alarm control unit.

### **3.4 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.

### **3.5 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. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents,

- Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
- b. Comply with "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 "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 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.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

**END OF SECTION 28 3111**





**SECTION 31 1000****CLEARING****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the contract including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials and work required to clear the project site.

**1.3 RELATED WORK**

- A. Refer to Section 31 20 00 "Earthmoving"

**1.4 STANDARDS**

- A. Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition.

**1.5 PROJECT CONDITIONS**

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.
  - 1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
  - 2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

**1.6 SUBMITTALS**

- A. Submit written notification to public utility companies, at least one week prior to planned work, for disconnection of active utilities.

**1.7 DEFINITIONS**

- A. Topsoil: A friable loam surface soil, free of subsoil, clay, lumps, weeds, roots, debris and stones exceeding one inch in any dimension.

## 1.8 CONSTRUCTION SURVEYS

- A. Provide survey equipment and qualified personnel for construction surveys. Provide stakes and/or flag trees to designate the limits of clearing operations.

## PART 2 - PRODUCTS

### 2.1 TEMPORARY TREE PROTECTION FENCING

- A. In accordance with M-NCPPC requirements, and as indicated.

## PART 3 - EXECUTION

### 3.1 PROTECTION AND RESTORATION

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Existing Trees: Protect existing trees, indicated "To Remain", and existing trees beyond the indicated "Clearing and Grading Limits" from the following:
  - 1. Cutting, breaking or skinning roots.
  - 2. Skinning or bruising bark.
  - 3. Stockpiling earth materials within drip line.
  - 4. Stockpiling construction materials within drip line.
  - 5. Vehicle parking within drip line.
  - 6. Excessive pedestrian or vehicular traffic.
- C. Temporary Tree Protection Fencing: Provide "Temporary Tree Protection" for trees indicated to remain, and as required for existing trees beyond the indicated "Clearing and Grading Limits". Install as indicated or required in accordance with the standards of the "Maryland Standards and Specifications for Soil Erosion and Sediment Control", and as noted.
  - 1. Install posts, spaced no more than 6 feet on center, by driving plumb to 18-inch depth. Stretch fence fabric between posts and fasten securely to steel posts with tie wire. Fastenings for hardwood posts shall be tie wire or staples.
- D. Water trees indicated "To Remain" during clearing and subsequent construction operations.
- E. Repair or remove and replace trees indicated "To Remain" or located beyond the indicated "Clearing and Grading Limits" and damaged by clearing or subsequent construction operations, with new trees of equal species, caliper and quality, as directed by the Architect, at no increase to contract sum.

### 3.2 CLEARING

- A. Clear the project site, removing trees and vegetation, within "Clearing and Grading Limits" indicated.

### 3.3 GRUBBING

- A. Completely remove stumps, roots and debris, within "Clearing and Grading Limits" indicated, to minimum 12-inch depth below existing ground surface. Employ manual methods for grubbing around trees indicated "To Remain".

### 3.4 TOPSOIL STRIPPING

- A. Strip topsoil, within "Clearing and Grading Limits" indicated. Remove heavy vegetation growth before stripping. Strip topsoil to all depths encountered. Strip topsoil to prevent intermingling with tree roots underlying subsoil.
  - 1. Do not strip topsoil within the drip line of existing trees indicated "To Remain", or located beyond the indicated "Clearing and Grading Limits".
- B. Stockpile topsoil, at locations approved by the Architect, until required for landscape development. Shape and grade stockpiles to prevent surface water ponding. Temporarily stabilize stockpiles as specified on the Prince George's County Approved Sediment Control Drawings.

### 3.5 WASTE MANAGEMENT

- A. Transport combustible and non-combustible waste materials from the project site to legal offsite disposal areas. Document legal offsite waste disposal areas. Burning of waste materials is prohibited.
- B. Recycle/compost/salvage site clearing debris in accordance with Division 1 "Construction Waste Management" requirements.

**END OF SECTION**



**SECTION 31 1005****DEMOLITION****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. The General Conditions, Supplementary Conditions and Division 1, General Requirements, are a part of this section.

**1.2 RELATED WORK**

- A. Refer to Section 31 20 00 "Earthmoving", and Division 26 "Electrical".

**1.3 DESCRIPTION OF WORK**

- A. This section specifies demolition of existing site improvements and underground utilities.

**1.4 CODES**

- A. For existing utilities refer to Section 31 20 00 "Earthmoving".

**1.5 PROJECT CONDITIONS**

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Existing Structures: The Owner has applied for the Demolition Permits for the partial demolition of the fire station.
  - 1. The Contractor shall be responsible for the investigation and removal of hazardous materials, including asbestos, from the structures to be demolished. In accordance with MCDPS requirements, all hazardous materials must be properly removed and discarded prior to issuance of the demolition permit.
  - 2. The Contractor shall be responsible for finalizing and obtaining the demolition permits for the structures indicated to be demolished. This includes payment of all associated fees.
  - 3. The Contractor shall be responsible for filing an application to WSSC for SDC credits from the demolished houses, to be provided to the owner. Obtain written agreement with the Owner and WSSC for the plumbing fixture counts for the buildings prior to demolition.
- C. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.

1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
  2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.
  3. The contractor shall be responsible for the removal/abandonment.
- D. Existing Subsurface Conditions: Verify existing pavement materials and respective thicknesses during prebid inspection. Obtain written authorization from the owner before conducting test hole explorations of existing pavements within the project site.
- E. Traffic: Obtain written authorization from the local jurisdiction or adjacent property owners prior to obstructing vehicular traffic and parking areas. Obtain written authorization from local jurisdiction prior to obstructing public rights-of-way and easements.
- F. Pre-bid Inspection Conditions: Conditions, existing during prebid inspections, will not be altered or modified.
- G. All work must be contained within the prescribed limits of disturbance shown on the contract documents.

#### 1.6 SUBMITTALS

- A. Submit written notifications to public utility companies for disconnection of active utilities.

#### 1.7 DEFINITIONS

- A. Demolition: Complete removal and disposal of existing facilities specified or indicated, "Remove".
- B. Salvage: Complete removal, by methods, which prevent damage or destruction of any items indicated to be relocated (or salvaged) and subsequent relocation and reinstallation in an area designated by Owner.

### **PART 2 - PRODUCTS: (Not Used)**

### **PART 3 - EXECUTION:**

#### 3.1 PROTECTION AND RESTORATION

- A. Refer to Section 31 10 00 "Clearing" and Section 31 20 00 "Earthmoving".
- B. Existing Facilities: Protect existing facilities and structures designated to remain, temporarily or permanently, from damage during demolition or construction activities. Re-

- pair items damaged during demolition or construction activities to their original condition, or replace with new. Do not overload structural elements or pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition and/or removal work. Repairs, reinforcement or structural replacement shall be approved by the Architect or the Owner's Representative.
- C. Weather Protection: For portions of the existing building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of roofing or walls is necessary to accomplish work, immediately provide adequate temporary covering of exposed areas to assure protection of remaining facilities.
- D. Existing Utility Services: The locations of underground utility services are approximate, and are taken from Owner's record information and record information provided by utility companies. Protect existing utility services designated to remain temporarily or permanently, or to be relocated or removed by others. Contractor shall sequence demolition and construction activities to minimize utility service interruptions to existing facilities to remain. Where removal of existing utility services is required for other site construction, provide temporary covering of exposed areas, and temporary service or connections for utilities until permanent utility service replacements are completed.
1. Contractor shall coordinate with affected utility companies to determine extent of relocation work to be done by others.
  2. Contractor shall coordinate utility relocation or removal by others with all phases of construction activity.

### 3.2 EXISTING SITE IMPROVEMENTS DEMOLITION

- A. Existing Structures: Demolish existing structures as indicated on the plans. All foundations, or other building elements, shall be removed completely. All utilities shall be abandoned/ removed per building code and utility company requirements. Cap all abandoned conduits.
- B. Existing Pavements: Demolish existing pavements, regardless of pavement thickness, to limits indicated at no increase to contract sum. Neatly saw cut existing bituminous concrete pavement to straight, smooth and sharp edges perpendicular to pavement surface.
1. Milling: Note that some portions of the site require milling. Milling operations shall be to the depth indicated on the drawings and performed in accordance with MDOT-SHA Standards and Specifications.
- C. Existing Curbing: Demolish existing curbing to limits indicated, unless nearest expansion joint is less than six (6) feet from the indicated limits of removal. In that case, remove existing concrete curbing to the nearest expansion joint beyond the indicated demolition limits at no increase to the Contract Sum. Neatly saw cut existing portland cement concrete curbing, to limits indicated, to smooth, clean and sharp edges perpendicular to top and face of curbing.

1. Contractor's Option: Remove existing concrete curbing to nearest expansion joint beyond demolition limits indicated at no increase to contract sum.
- D. Existing Entrances and Aprons: Demolish existing entrances and aprons indicated.
1. Remove all privately owned mailboxes and posts.
  2. Remove existing driveway culverts and restore the disturbed area including the existing roadside ditch. This will include installing sod within the disturbed areas.
  3. All work within the public street right-of-way will be accomplished in accordance with permits from Montgomery County and requirements of the inspection authority.
- E. Miscellaneous: Demolish existing fencing indicated, including posts, footings and related appurtenances. Demolish additional miscellaneous existing site improvements indicated, specified and required to construct project.

### 3.3 EXISTING OVERHEAD UTILITY DEMOLITION

- A. Existing electrical facilities will be removed by Potomac Electric and Power Company. Contractor shall contact PEPCO to schedule and arrange for payment for removals.
- B. Existing telephone facilities will be removed by Telephone Company. Contractor shall contact Telephone Company to schedule and arrange for payment for removals.
- C. Existing cable television facilities will be removed by Comcast Cable Company. Contractor shall contact Comcast to schedule and arrange for payment for removals.

### 3.4 EXISTING UNDERGROUND UTILITY DEMOLITION

- A. Excavate and expose existing underground utilities and related structures designated for, or as required to implement, removals. For excavation operations refer to Section 33 10 00 "Utility Standards". Remove existing utility structure castings. Backfill excavations, upon completion of utility demolition operations. For backfill operations refer to Section 33 10 00 "Utility Standards".

### 3.5 MAINTENANCE

- A. Refer to Section 31 20 00 "Earthmoving".

### 3.6 SALVAGE MATERIALS

- A. Carefully remove items designated for Salvage, or "Remove and Relocate", to avoid damage. Store site items indicated for salvage, or "Remove and Relocate", to prevent damage during construction. Relocate items as indicated on site plan or as directed in the field by the Owner's Representative. Contractor shall replace salvage items damaged during removal, storage or relocation operations at no increase to the Contract sum.



**3.7 WASTE MANAGEMENT**

- A. Transport demolition waste materials from the project site to legal offsite waste disposal areas. Document legal offsite waste disposal areas.
- B. Recycle waste demolition materials in accordance with Division 1 "Construction Waste Management" requirements.

**END OF SECTION**



**SECTION 31 2000  
EARTHMOVING**

**PART 1 - GENERAL**

**1.1 RELATED DRAWINGS**

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

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials, equipment and work required to perform earthwork and grading operations for site development.

**1.3 TESTING AND INSPECTIONS**

- A. The Owner shall be responsible for providing a Maryland Registered Professional Soils Engineer for required testing and inspections.
- B. Services of the Soils Engineer will not necessarily be on a full time basis, but will include the number of visits and tests required to observe the performance of all earthwork under this Section. If in the opinion of the Soils Engineer, any work performed under this Section does not meet the technical or design requirements stipulated for the work, the Contractor shall make all necessary re-adjustments to his approval.
- C. All earthwork procedures shall be performed in the presence of the Soils Engineer. Give adequate (24 hours) notice when Soils Engineer's services are required.

**1.4 RELATED WORK**

- A. Refer to Section 31 10 00 "Clearing", Section 31 10 05 "Demolition"

**1.5 CODES**

- A. Contractor shall comply with the applicable requirements of the governing agencies having jurisdiction.

**1.6 DEFINITIONS**

- A.     Excavation:   Removal of earth materials to subgrade elevations indicated or specified.
- B.     Over-Excavation:   Removal of earth materials, beyond subgrade elevations indicated or specified, without written authorization from the Architect.

- C. Unsuitable Earth: Soft or unstable earth materials beyond limits of excavation indicated (e.g. muck, soft clays, organic soils, peat, etc.). If soils on-site are encountered that do not comply with this Specification, the contractor shall remove said soils from the site and replace them with soils that meet the requirements of the specifications. The Contractor should assume in their bid that there are 5,000 cubic yards of unsuitable soils on-site that will need to be removed and replaced with material that meet the requirements of the specifications. The Contractor shall document the volume of removal of unsuitable material from the site and provide delivery tickets indicating the volume removed. The volume of unsuitable soil removed from the site must be verified by a County Representative on a daily basis. In addition, the Contractor shall provide copies of the Geotechnical Engineer's recommendation to remove the material from the site. The Contractor shall make every reasonable effort to see if modifications can be made to substandard soils to make them meet the specifications (i.e. grinding rocks to meet the size requirements, spreading wet soils to allow them to dry, etc.). If the volume of soil removal is greater than the volume noted above, the removal and replacement shall be in accordance with the Unit Prices in Section 01 22 00. If the volume of soil removal is less than the volume noted above, the Contractor shall provide a credit for not having to remove and replace this material in accordance with the Unit Prices in Section 01 22 00.
- D. Fill: Placement of earth materials over existing ground surfaces to subgrade elevations indicated or specified.
- E. Backfill: Placement of earth materials in excavations to subgrade elevations indicated or specified.
- F. Soils Engineer: Shall be a Professional Engineer, currently registered in the State of Maryland, or shall be an authorized representative of such an engineer.

#### 1.7 SUBMITTALS:

- A. Density Test Results: The Contractor shall submit copies of the results of the specified density testing to the Owner's Representative for review and approval.
- B. Submit location of product manufacture and of extraction/recovery of primary raw materials.
- C. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.

**1.8 PROJECT CONDITIONS:**

- A. Refer to Section 12.4.1 of the General Conditions.
- B. Existing Subsurface Conditions: A subsurface investigation has been conducted at the project site to determine general subsurface conditions. A copy of the report is available from the County upon receipt from the Bidder/Contractor of an executed release form, prepared by the County, stating that said Bidder/Contractor cannot rely upon the County's geotechnical information as a basis for any claims for additional compensation in executing the Work indicated in the Project Documents. The Owner will not be responsible for interpretations or assumptions made by the Contractor. Additional subsurface investigations may be made by the Contractor at no increase to the contract sum. Obtain written authorization from the Owner before proceeding with subsurface investigations.
- C. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.
  - 1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
  - 2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

**1.9 CONSTRUCTION SURVEYS:**

- A. Provide survey equipment and qualified personnel for construction surveys. Provide combined vertical and horizontal stakes required to perform earthwork operations to subgrade elevations indicated or specified.

**1.10 EARTHWORK BALANCE:**

- A. Perform all earthwork operations regardless of actual quantities encountered.
  - 1. Excess materials shall be legally disposed of off project property.
  - 2. Off-site borrow shall be provided at no increase to the Contract sum.

**PART 2 - PRODUCTS:****2.1 MATERIALS:**

- A. Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the project site.
- B. Fill Materials: Soils used as fill materials shall have Unified Soils Classification (ASTM D 2487) of ML, SM, SC or more granular, but shall exclude highly plastic clays or silts (MH-CH). Soil material for fill shall be free of organic matter or debris, waste materials, frozen materials, vegetable matter and rock or stones exceeding three inches in any dimension. No more than 15 percent of rocks or lumps shall be larger than 2½ inches in any dimension. Materials shall be non-frost susceptible soils, and shall have a liquid limit of less than 40 and a plasticity index of less than 12; the maximum dry density shall not be less than 105 pounds per cubic foot as determined by AASHTO T-99, Method C. RC-6 recycled concrete shall be used as fill and subbase material, except under building slab, as performance requirements permit.
  - 1. Fill material used within the top 12 inches of fill shall be free of rocks or stones exceeding two inches in any dimension.
- C. Backfill Material: As indicated for fill material.
- D. Borrow Material: Off-site borrow, if required, shall be as specified for Fill Materials. Obtain and transport borrow material at no increase to the Contract sum.

### **PART 3 - EXECUTION:**

#### **3.1 PROTECTION AND RESTORATION:**

- A. General: Provide protection to prevent settlement, movement, undermining of or erosion to existing site improvements, existing utilities, existing buildings, new site improvements, new buildings and new utilities.
- B. Do not permit heavy equipment to pass over any utility until a minimum of two feet of compacted fill or backfill is placed over the top of utility.
- C. Restore damage, at no increase to Contract sum, resulting from the lack of protection or improper installation of protective measures or careless execution of construction activities. Restoration work to be approved by the Soils Engineer and Owner's Representative.

#### **3.2 EXISTING UTILITIES:**

- A. Notify all public utility companies, 48 hours prior to the start of earthwork operations. Verify and mark horizontal utility locations prior to the start of

earthwork operation. Manually excavate and expose utilities as earthwork operations approach marked locations.

- B. Immediately notify the Owner's Representative or the Architect in the event horizontal or vertical utility locations differ from locations indicated. Provide horizontal and vertical details of utility locations as directed by the Owner's Representative or the Architect. Conflicts with construction to be determined by the Owner's Representative or the Architect. Payment for correction of unforeseen conflicts with construction shall be by change order.
- C. Coordinate public utility relocation work required for public utilities conflicting with construction. The Owner's Representative or the Architect will provide directions and details required to relocate utilities conflicting with construction.
- D. Do not disconnect or interrupt existing utilities serving existing facilities to remain without notification and authorization of the Architect or the Owner's representatives.

### **3.3 DEWATERING:**

- A. Perform earthwork and grading operations to prevent surface or subsurface water from flowing into excavations, surface or subsurface water from flooding project site or adjacent property and water accumulations detrimental to stability of subgrades. Provide, install, operate and maintain all required pumps, sumps, discharge lines and related equipment.

### **3.4 EXCAVATION:**

- A. Excavate materials encountered to subgrade elevations indicated or specified by the Soils Engineer. All excavation is unclassified. Excavate materials regardless of the character of the materials encountered, at no increase to contract sum.
- B. Subgrade Preparation: Upon completion of excavation activities, exposed subgrade shall be proofrolled utilizing a heavily loaded dump truck or other pneumatic-tired vehicle of similar size and weight, in the presence of the Soils Engineer. Proofrolling shall not be performed during or following wet weather conditions. Any unsuitable materials discovered during proofrolling operations shall be removed and replaced as specified below. Upon completion of proofrolling activities and approval of the subgrade by the Soils Engineer, exposed subgrade shall be further prepared as follows:
  - 1. Unpaved Areas: Scarify subgrade to six-inch depth prior to topsoil placement.



2. Paved Areas: Scarify subgrade to twelve-inch depth and compact to 95 percent maximum dry density. Density test methods: ASTM D 1557. Remove unsuitable earth, exhibiting excessive weaving during compaction operations, as specified.

### **3.5 OVER-EXCAVATION:**

- A. Correct over-excavated areas as directed by the Soils Engineer. Remove unsuitable earth encountered as a direct result of over-excavation. Excavate and dispose of all unsuitable earth. Correct excavated area as directed.

### **3.6 UNSUITABLE EARTH:**

- A. Immediately notify the Soils Engineer in the event unsuitable earth is encountered during earthwork or subsequent construction operations. Stop all work within immediate area of unsuitable earth. Do not remove unsuitable earth until direction is received from the Soils Engineer. Excavate and dispose of all unsuitable earth. Backfill excavated area as specified and directed by the Soils Engineer. Removal of and backfill for unsuitable soils shall be at the Contractors expense.

### **3.7 EXCAVATED MATERIAL STORAGE:**

- A. Stockpile select excavated materials required for fill and/or backfill operations. Stockpile locations to be approved by the Owner's Representative or the Architect. Shape and grade stockpiles to prevent ponding of surface water. Temporarily stabilize stockpiles as specified on the Soil Erosion and Sediment Control Drawings. Dispose of excess excavation materials as specified.
  1. Excess excavated material shall be legally disposed of by removal from the project site.

### **3.8 EARTH FILL:**

- A. Existing Ground Surface Preparation: Remove vegetation and topsoil as specified in Section 311000 "Clearing". Proofroll exposed subgrade utilizing a heavily loaded dump truck or other pneumatic-tired vehicle of similar size and weight, in the presence of the Soils Engineer. Proofrolling shall not be performed during or following wet weather conditions.
- B. Existing Subgrade Preparation: Remove unsuitable earth, upon completion of clearing and proofrolling operations, as specified. Continuously bench

existing slopes exceeding four feet horizontal to one foot vertical. Bench sufficiently to accommodate earthmoving and compaction equipment. Select material, removed as a result of benching operations, may be used for fill and/or backfill as specified.

1. Unpaved Areas: Scarify existing subgrade to six-inch depth and compact to 90 percent maximum dry density. Density test method: ASTM D 1557.
  2. Paved Areas: Scarify existing subgrade to twelve-inch depth and compact to 95 percent maximum dry density. Density test method: ASTM D 1557. Remove unsuitable earth, exhibiting excessive weaving during compaction operations, as specified.
- C. Fill Placement: Do not place fill material on frozen or muddy subgrades.
1. Unpaved Areas: Place fill material in loose lifts not exceeding eight-inches.
  2. Paved Areas: Place fill material in loose lifts not exceeding eight-inches.
- D. Fill Compaction and Moisture Control: Obtain compaction with approved compaction equipment. Provide compaction equipment of proper size and in proper mechanical operating condition. All fill material shall be moisture conditioned to within two percent of optimum moisture content.
1. Unpaved Areas: Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 698.
  2. Paved Areas: Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698. The top 12 inches of pavement subgrade soils shall be compacted to at least 100 percent maximum dry density per ASTM D 698.
- E. Control moisture during placement and compaction operations. Remove and replace or scarify and aerate excessively moist material until required moisture content is obtained. Moisten excessively dry material by applying measured amounts of water uniformly to fill material until required moisture content is obtained.

### **3.9 EARTH BACKFILL:**

- A. General: Backfill excavations as promptly as work permits, but not until completion of inspection, testing and approval by the Soils Engineer.
- B. Placement and Compaction: Do not place backfill on frozen or muddy subgrades.
1. Unpaved Areas: Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 90 percent maximum dry density. Density test method: ASTM D 1557.

2. Paved Areas: Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 1557.
3. All material to be moisture conditioned to within two percent of optimum moisture content.

### **3.10 GRADING:**

- A. General: Grade unpaved and paved areas to smooth and uniform surfaces and to prevent ponding of surface water.
  1. Unpaved Areas: Areas to receive topsoil shall be graded to allow for installation of 6 inches of topsoil. Grade slopes exceeding four feet horizontal to one foot vertical, to smooth and uniformly rounded surfaces.
  2. Paved Areas: Grade paved area subgrades to the lines, elevations and sections indicated or specified.

### **3.11 MAINTENANCE:**

- A. Maintain all paved access roads in a clean and dust free condition during earthwork or subsequent construction operations. Clean trucks and equipment, removing mud and debris, prior to entering project site access roads and public right-of-way.
- B. Maintain completed areas of project site free of trash and debris. Scarify, regrade and recompact subgrades damaged or disturbed by adverse weather, soil erosion, settlement and subsequent construction operations.

### **3.12 TESTING:**

- A. The following tests will be conducted.
  1. Laboratory Density Tests:
    - a. Test method: As specified.
    - b. Test interval: One test per each 15,000 s.f., or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines, and 1 per each 5,000 s.f., etc, for areas done by hand-operated machines.
  2. In-place Field Density Tests:
    - a. Test method: ASTM D 1556-82 or D 2167.
    - b. Density required: As specified.
    - c. Test Interval: One test per 2,000 s.f., or fraction thereof, of compacted subgrade, or of each lift of fill or backfill compacted by other than hand-operated machines, and 1 per 1000 s.f., etc, for each lift of fill or backfill compacted by hand-operated machines..

- B. Correct work not conforming to specified densities as directed by the Soils Engineer, at no increase to the Contract Sum.

**3.13 WASTE MANAGEMENT:**

- A. Recycle or salvage waste earthwork materials in accordance with Division 1 "Construction Waste Management" requirements.

**END OF SECTION**

**SECTION 31 2005****BUILDING EARTHWORK****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, specification sections, apply to work of this section.

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials, equipment and work required to perform building earthwork operations.

**1.3 TESTING AND INSPECTIONS**

- A. Refer to Section 31 20 00 "Earthmoving".
- B. All earthwork procedures shall be performed in the presence of the Soils Engineer. Give adequate (24 hours) notice when Soils Engineer's services are required. The Soils Engineer's duties will include, but not be limited to the following:
  - 1. Observation, testing, and approval of subgrade for footings before placement of concrete.
  - 2. Observation and approval of floor subgrade and fill placement before placement of under floor granular base.
  - 3. Testing of proposed import fill material and verification of correlation of the import material to laboratory test samples. All test results shall be forwarded to the seeding and sodding contractor.
  - 4. Verification of removal of sediment from sediment control basins and testing of subgrade in basins prior to fill placement.

**1.4 RELATED WORK**

- A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving".

**1.5 CODES**

- A. Refer to Section 31 20 00 "Earthmoving".

**1.6 STANDARDS**

- A. Refer to Section 31 20 00 "Earthmoving".

**1.7 SUBMITTALS**

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Product Samples: Submit samples of the borrow material and structural fill material to the Soils Engineer. Sample size to be fifty pounds. Number of samples to be determined by the Soils Engineer.
- C. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.
- D. Submit location of product manufacture and of extraction/recovery of primary raw materials.

## 1.8 DEFINITIONS

- A. Refer to Section 31 20 00 "Earthmoving".

## 1.9 PROJECT CONDITIONS

- A. Refer to Section 31 20 00 "Earthmoving".
- B. All work must be contained within the prescribed limits of disturbance shown on the contract documents.

## 1.10 CONSTRUCTION SURVEYS

- A. General: Retain the services of a Maryland Registered Land Surveyor or Maryland Registered Professional Engineer to provide horizontal and vertical alignment stakes required to perform building earthwork operations to subgrade elevations indicated or specified, and horizontal and vertical alignment stakes required to construct footings and foundations.
- B. Earthwork Balance Conditions: Refer to Section 31 20 00 "Earthmoving".

# PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. General: Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the Project Site.
- B. Fill Material: ASTM D 2487, Unified Soils Classification SM or better. Liquid limit not to exceed forty (40). Plasticity Index not to exceed twenty (20). Maximum particle size to be 2-1/2 inches. Free of debris, organic materials, waste materials and frozen materials. Obtain and transport fill materials from project site or borrow areas at no increase to contract sum.
  - 1. Recycled concrete RC-6 may, at Contractor's discretion, be used for fill in approved locations.

- C. Samples: Submit fill material samples for testing and approval to the Soils Engineer. Do not place fill until written approval is obtained. Sample approval will not relieve the contractor of the responsibility to have material placed conform to approved samples.
- D. Porous Fill: ASTM C 33 Coarse Aggregate, size number 467 (1-1/2 inch to No. 4), blast furnace slag prohibited.
  - 1. Size to be AASHTO M 43, size 57.
- E. Backfill Material: Refer to Section 31 20 00 "Earthmoving".

### **PART 3 - EXECUTION**

#### **3.1 PROTECTION AND RESTORATION**

- A. Refer to Section 31 20 00 "Earthmoving" and as noted. Provide support systems (e.g. sheeting, shoring, sheet piling, cribbing, etc.) at no increase to contract sum. Protect footing, foundation and slab subgrades, with insulating materials, to prevent frost penetration. Restore subgrades damaged from the lack of protection. Restoration work as directed by the Soils Engineer.

#### **3.2 DEWATERING**

- A. Refer to Section 31 20 00 "Earthmoving" and as noted. Perform building earthwork operations to prevent water accumulations detrimental to stability of footing and foundation subgrades.

#### **3.3 EXCAVATION**

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Foundation Excavation: Excavate to footing and foundation elevations indicated or specified. Extend excavations horizontally beyond footings and foundations to permit formwork placement and removal, support system placement and removal, building utility installations, waterproofing and inspection. Do not place concrete until completion of inspections, testing and approval by the Soils Engineer. Trim and shape excavations by manual methods, prior to concrete placement.
- C. Slab Excavation: Excavate to slab subgrade elevations indicated or specified. Excavate slab subgrades to smooth and even surfaces, free of voids and depressions. Prepare exposed subgrades as specified for paved areas, Section 31 20 00 "Earthmoving". Do not place concrete or porous fill until completion of inspection, testing and approval by the Soils Engineer. Inspection, testing and approval of subgrade shall be performed immediately prior to placement of porous fill and concrete.

- D. Below Slab Utility Excavation: Refer to Section 33 10 00 "Utility Standards" and as noted.
  - 1. Trench width below and 12 inches above top of utility not to exceed 12-inch clearance on each side of utility.

### 3.4 OVER-EXCAVATION

- A. Refer to Section 31 20 00 "Earthmoving" except as noted. Correct over-excavated areas as directed by the Soils Engineer or Owner's Representative.

### 3.5 UNSUITABLE EARTH

- A. Refer to Section 31 20 00 "Earthmoving"

### 3.6 EXCAVATED MATERIAL STORAGE

- A. Refer to Section 31 20 00 "Earthmoving".

### 3.7 FILL:

- A. Refer to Section 31 20 00 "Earthmoving", except as noted.
- B. Earth Fill: Prepare exposed subgrades as specified for paved areas, Section 31 20 00 "Earthmoving". Place fill material in loose lifts not exceeding eight inches and at moisture content within plus or minus two percentage points of optimum moisture content, and compact to 95 percent maximum dry density. Density test method: ASTM D 698.
  - 1. Compacted fill material shall extend at least ten feet beyond building lines for lateral support.
  - 2. Do not place concrete or porous fill until completion of inspection, testing and approval by the Soils Engineer. Inspection, testing and approval of subgrade shall be performed immediately prior to placement of porous fill and concrete.
- C. Porous Fill: Upon approval of prepared subgrade, place porous fill in uniform lifts and compact to 70 percent relative density.

### 3.8 BACKFILL

- A. Refer to Section 31 20 00 "Earthmoving". Place and compact backfill as specified for fill, except as noted.
- B. Backfill excavations as promptly as work permits, but not until completion of formwork removal, foundation drainage system installation, building utility installations, waterproofing, termite treatment, trash and debris removal, support system removal, temporary and/or permanent wall bracing installation, and inspection and approval by the Soils Engineer.
- C. Exercise care in the placement of backfill material adjacent to structure. Place backfill evenly and in a manner to prevent wedging action against the struc-



ture. Place backfill uniformly around the structure in lifts of equal elevation. Correct damage from improper backfilling operations, as directed by the Soils Engineer or Owner's Representative, at no increase to the Contract Sum.

- D. Backfill placement operations to be tested and approved by the Soils Engineer.

### 3.9 TESTING

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Foundation Subgrade Testing: For each stratum of soil, on which foundations will be placed, conduct one test to verify required design bearing capacities. Conduct a minimum of one test beneath each wall. Subsequent verification and approval of each foundation subgrade may be based on a visual comparison of each subgrade with related tested strata. Additional testing shall be conducted as required by the Soils Engineer.

### 3.10 MAINTENANCE

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Tests, inspections, and approvals specified will be conducted in accordance with applicable Division One Sections regarding "Testing Services".

### 3.11 WASTE MANAGEMENT

- A. Recycle or salvage waste earthwork materials in accordance with Division 1 "Construction Waste Management" requirements.

**END OF SECTION**



**SECTION 313116**  
**TERMITE CONTROL**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Related Sections:
  - 1. Section 312000 – Earth Moving.
  - 2. Section 329300 -Plants.

**1.2 SUBMITTALS**

- A. General: Submit in accordance with Section 013300.
- B. Certification: Submit certifications specified in Quality Assurance article.
- C. Closeout Submittals:
  - 1. Product Record Documents:
    - a. Submit documents under provisions of Section 017700.
    - b. Accurately record moisture content of soil before treatment, date and rate of application, areas of application, diary of meter readings and corresponding soil coverage.
- D. Warranty: Signed and dated by Contractor, applicator and manufacturer.

**1.3 QUALITY ASSURANCE**

- A. General: Comply with manufacturer's instructions and recommendations for work, including preparation of substrate and application.
- B. Manufacturer's Qualifications: Manufacturer's chemicals approved by EPA for termite control use.
- C. Applicator Qualifications:
  - 1. Licensed in accordance with regulations of governing authorities for application of soil treatment solution and in good standing with Structural Pest Control Board of State of Project location.
  - 2. Company specializing in soil treatment for termite control with 5 years documented experience.
  - 3. Submit applicator qualifications verifying years of experience; include list of completed projects identified by name, location, date, reference names and phone numbers.
- D. Certifications: Submit certification signed and dated by pest control applicator certifying following:
  - 1. Pest control applicator has state license and five years of documented professional experience.
  - 2. Only termite control materials that have EPA approval and registration will be used.
  - 3. Application shall comply with EPA requirements, manufacturer's instructions, and National Pest Control Association recommended procedures for work including preparation of substrate.
  - 4. Manufacturer's documentation confirming formulation, concentration, and method of application is appropriate for five year warranty period.
  - 5. Owner shall be furnished with annual Inspection/Certification throughout and at completion of warranty period to substantiate that Project has been maintained termite free.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with requirements of Section 016000.
- B. Deliver chemicals in sealed containers bearing manufacturer's labels indicating following:
  - 1. Evidence of registration under EPA Federal Insecticide, Fungicide, and Rodenticide Act.
  - 2. Instructions for handling.
  - 3. Application procedures.
- C. Store chemicals at temperature above 32°degrees F. Do not store chemicals near heat or open flame.

**1.5 PROJECT CONDITIONS**

- A. Do not apply soil treatment solution until excavating, filling, and grading operations are complete, except as required in construction operations.
- B. To ensure penetration, do not apply soil treatment to frozen or excessively wet soils, or during inclement weather.

**1.6 WARRANTY**

- A. Provide warranties in accordance with Section 017700.
- B. Furnish written warranty certifying that applied soil treatment prevents infestation of subterranean termites and that if subterranean termite activity is discovered during warranty period, soil will be retreated and damage caused by termite infestation will be repaired or replaced at no additional cost to Owner.
- C. Provide warranty for period of 5 years from date of treatment signed by applicator, manufacturer, and Contractor.

**1.7 MAINTENANCE**

- A. Provide annual inspection during 5 year warranty period and at termination of 5 year warranty. Submit annual certificate to Owner stating that Project is free of termites.
- B. If termite colony is discovered within warranty period, retreat area to eliminate colony and repair damage caused by termites at no additional cost to Owner.

**PART 2 - PRODUCTS****2.1 MATERIALS**

- A. Termite Control:
  - 1. Emulsifiable concentrate insecticide for dilution with water specially formulated to prevent infestation by termites and not injurious to vegetation.
  - 2. Provide working solution of chemical elements and water as allowed for use by local governing authorities and federal EPA to prevent infestation of termites.
  - 3. Provide synthetic dye in solution to permit visual identification of treated soil.
- B. Water: Potable.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine conditions and proceed with work in accordance with Section 017300.
- B. Verify that soil is in friable condition with moisture content low enough to permit absorption of toxicant solution.

**3.2 PREPARATION**

- A. Take precautions to avoid contamination of areas other than those necessary to receive soil treatment.
- B. Remove foreign matter which could decrease effectiveness of treatment on areas to be treated. Loosen, rake and level soil to be treated, except previously compacted areas under slabs and foundations. Toxicants may be applied before placement of compacted fill under slabs, if recommended by toxicant manufacturer.

**3.3 APPLICATION**

- A. Comply with application and mixing instructions of soil toxicant manufacturer and governing authorities.
- B. Slab-on-Grade Structures:
  - 1. Treat soil before concrete slabs or vapor retarders are placed.
  - 2. Treat areas under slab, along inside of foundation walls, along sides of interior partition walls and around plumbing.

3. Provide additional treatment to areas containing penetrations through slab-on-grade, foundation walls, grade beams, expansion joints, and control joints.
  - C. Trenches:
    1. Apply chemicals for each foot of depth from grade to footing, along outside edge of building.
    2. Dig trench 6 to 8 inches wide along outside of foundation to depth of not less than 12 inches, punch holes to top of footing at not more than 12 inches OC and apply chemical solution.
    3. Mix chemical solution with soil as it is being replaced in trench.
  - D. Basements and Crawl Spaces:
    1. Treat soil along exterior and interior walls of foundation with shallow footings.
    2. Treat soil under or around crawl space structures, along inside of foundation walls, along both sides of interior partitions, and around piers and plumbing; do not apply overall treatment in crawl spaces.
  - E. Coordinate soil treatment at foundation perimeter with finish grading and landscaping work to avoid disturbance of treated soil. Retreat disturbed treated soil.
  - F. Prevent access for 12 hours minimum to allow drying after application, before beginning concrete placement or other construction activities.
  - G. Post signs in areas of application warning that soil poisoning has been applied. Remove signs when areas are covered by other construction.
- 3.4 ADJUSTING**
- A. Remove and replace areas contaminated by termite control materials not required to be treated.
  - B. Reapply soil treatment solution to areas disturbed by subsequent excavation or other construction activities following application. Utilize same chemical used for original treatment.

**END OF SECTION**



**SECTION 31 5000****EXCAVATION SUPPORT AND PROTECTION****PART 1 – GENERAL****1.1 SUMMARY**

- A. Work of this section includes sheeting and shoring and bracing.

**1.2 RELATED SECTIONS**

- A. Section 31 10 00: Clearing
- B. Section 31 20 00: Earthmoving

**1.3 SYSTEM DESCRIPTION DESIGN REQUIREMENTS**

- A. Shoring systems shall be designed to safely and adequately prevent collapse of adjacent materials and permit construction of Work to arrangement shown on Contract Documents.
- B. Secure approvals, including those of local governmental agencies having jurisdiction.
- C. Analyze site conditions. Make supplemental investigations as needed for proper design of shoring.

**1.4 QUALITY ASSURANCE SUBMITTALS FOR DESIGN DATA**

- A. Prepare and submit design drawings and calculations showing analysis of work to be performed, including horizontal support for shoring.
- B. Drawings shall include methods, equipment and work procedures.

**1.5 QUALITY ASSURANCE**

- A. Qualifications
  - 1. Bracing and shoring drawings shall be prepared by a registered professional engineer, licensed to practice in the State of Maryland. Drawings and calculations shall bear seal of Professional Engineer registered in the State of Maryland.
  - 2. Personnel performing installation shall be trained or qualified in techniques and procedures of shoring installation with a minimum of three (3) years successful experience in such installation.
  - 3. Installation shall be performed under supervision of a Professional Engineer

registered in the State of Maryland, experienced in this type of work.

- B. Regulatory Requirements: Conform to requirements of Occupational Safety and Health Administration (OSHA) as well as measures accepted as standards of industry.
- C. Certifications: Upon completion of shoring, submit a letter signed and sealed by design engineer stating that, to best of his or her knowledge, systems were constructed in compliance with design drawings and calculations.



**PART 2 – PRODUCTS****2.1 MATERIALS**

- A. Materials shall be selected and furnished to perform in compliance with design criteria.
- B. Structural Steel Shapes and Plates: ASTM A 36 or ASTM A 572. Steel shall be of American manufacturer, new and free from defects in strength, durability, appearance and function.

**PART 3 – EXECUTION****3.1 EXAMINATION**

- A. Site Verification of Conditions: Prior to commencing work of this Section, check and verify governing dimensions and elevations, including field measurements of existing or adjoining work on which this work is dependent to assure proper fit and clearances between new and existing structures.

**3.2 PREPARATION**

- A. Protection
  - 1. Protect and support water, sewer, gas, and other pipes and electrical conduits encountered and immediately notify persons, companies or governmental agencies, granting them ample opportunity to take such additional precautions as they may deem necessary.
  - 2. Cut and cap street connections encountered in excavating along curb lines in compliance with local jurisdiction requirements. Mark locations of capped utilities so they may be subsequently located and reconnected as needed.
  - 3. Damage to adjacent properties, streets, sidewalks and utilities caused by work under this Section shall be repaired, restored to original condition, or replaced at no additional expense to Owner.
- B. Coordination
  - 1. Prepare a photographic or video survey of existing crack conditions in adjacent facilities and other conditions of structures prior to commencing work.
  - 2. Maintain free flow of pedestrian and vehicular traffic to and from adjacent properties at levels existing prior to start of work and as described in Section 311000 "Clearing".
  - 3. Interior bracing shall be arranged to offer no interference with formwork for new construction.
  - 4. Provide sufficient quantity of materials on hand at all times for protection of Work and for use in event of emergency.

5. Setting of formwork, reinforcing and placement of concrete shall be in compliance with requirements described in other related Sections of this Project Manual.
  6. Provide pumps and other equipment as necessary to dewater excavations for shoring operations.
- C. Sheeting
1. Provide sheeting of proper lengths and section needed, and anchor or brace to resist earth and hydrostatic pressures and superimposed loads from adjacent structures and/or construction equipment.
  2. Install sheeting plumb and true, to lines and locations as indicated on design submittal drawings. Sheeting shall be used to form concrete walls and shall be located and driven to ensure that no part of sheeting is within outline of permanent construction.
  3. Sheeting retaining earth on which support and stability of existing structures is dependent shall be left in place at completion of Work.
- D. Shoring
1. Locate shoring at distances away from new construction sufficient to allow working room and observation of construction.
  2. Shoring shall be set clear of permanent footings, walls and other structural features.
  3. Shoring shall be installed to retain earth under surcharges, including such loads as weight of construction materials and equipment, vibration, snow, rainwater, water absorption by soils, and temporary construction.
  4. Extend shoring as high as necessary to allow for construction of foundation walls and for berming to divert water run-off. Depth of shoring shall be as deep as necessary to brace excavation to ultimate depth.
  5. Shoring supporting formwork may not be left in place upon written approval by the Owner's Representative.

### 3.3 RESTORATION

- A. Remove temporary protective installations upon completion of shoring operations.
- B. Repair damage to structures caused by shoring operations and restore surfaces to original or better condition.

### 3.4 CLEANING

- A. Remove debris and excess earth resulting from shoring operations as it accumulates. Do not store debris on site or permit debris to be scattered over site.

END OF SECTION

**SECTION 32 1216****HOT-MIXED ASPHALT PAVING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1, Specification Sections, apply to work in this section.

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials and work required to construct new asphalt pavement, asphalt curbing, asphalt walks and overlay existing asphalt pavement.

**1.3 RELATED WORK**

- A. Refer to Section 31 10 00 "Clearing", Section 31 10 05 "Demolition", Section 31 20 00 "Earthmoving", Section 32 13 13 "Cement Concrete Paving".

**1.4 STANDARDS**

- A. Maryland Department of Transportation State Highway Administration, current "Standard Specifications for Construction and Materials".
- B. Montgomery County Department of Transportation current "Design Standards".

**1.5 SUBMITTALS**

- A. Products:
  - 1. Submit asphalt plant mix formula, for each course specified. Mix formula to include percentage of aggregate passing each sieve size, percentage of bituminous material added to aggregate and mix temperature.
  - 2. Submit certificates, signed by producer or manufacturer and contractor, stating that base course material and asphalt comply with this specification.
  - 3. Submit results of testing specified for review by the Architect, Owner's Representative and required jurisdictional inspectors.
  - 4. Submit location of product manufacture and of extraction/recovery of primary raw materials.
  - 5. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled materials.

## 1.6 PRODUCT DELIVERY AND STORAGE

- A. Asphalt mixtures: Delivery temperature not to exceed 25° F below plant mix temperature.

## 1.7 PROJECT CONDITIONS

- A. Existing Asphalt Pavements: Verify existing pavement conditions (e.g. deteriorated surface, joints, etc.) during prebid inspection.
- B. Traffic: Maintain vehicular traffic during pavement construction operations.
- C. Limitations: Do not proceed with pavement construction until underground utility construction is complete. Do not proceed with asphalt placement operations until adjacent or adjoining Portland cement concrete curb construction is complete. Do not place bituminous materials when ambient air temperature is below 40° or air temperature has been below 35° F for 12 or more consecutive hours. Do not place materials from 15 November to 1 March without written authorization from the Architect.
- D. Construction Surveys: Retain the services of a registered land surveyor or professional engineer to provide combined horizontal and vertical alignment stakes for road base construction.
  - 1. Paved area base alignment stake horizontal interval: 50 foot maximum stations at centerline and both edges to finished base elevations.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Provide products manufactured and of raw materials extracted/recovered within a 500-mile radius of the Project Site.
- B. Subbase Course: SHA Graded Aggregate Subbase: Section 901.01.
  - 1. Recycled concrete RC-6 may, at Contractor's discretion, be used for base in approved locations.
- C. Asphalt Base (Binder) Course: SHA Hot Mix Asphalt: Sections 901.01, 904.01 and 904.06, band designation BI.
- D. Tack Coat: SHA cut-back asphalt: Section 904.04, M 81 or M 82.
- E. Overlay Binder Coat: Asphalt cement: AASHTO M 20, penetration grade 80-100.

- F. Overlay Protective Membrane: "Petromat" protective membrane manufactured by Phillips Fiber Corporation, a subsidiary of Phillips Petroleum Company, Greenville, South Carolina.
  - 1. Option: "AmoPave" protective membrane manufactured by Amoco Fabrics Company, Atlanta, Georgia, or approved equal.
- G. Overlay Protective Membrane Strips: "PavePrep" fiber reinforced mastic strips, manufactured by The PavePrep Corporation, Westfield, New Jersey.
- H. Asphalt Surface Course: SHA Hot Mix Asphalt: Section 901.01, 904.01 and 904.06.
- I. Asphalt Surface Course for Athletic Courts and Paved Play Areas: SHA Hot Mix Asphalt: Sections 901.01, 904.01 and 904.06.
- J. Joint Sealant: SHA Section 911.01.

### **PART 3 - EXECUTION**

#### **3.1 PROTECTION AND RESTORATION**

- A. Asphalt Pavement: Protect improvements and facilities during tack coat and overlay binder coat applications to prevent overspray damage. Protect completed surface from damage. Do not permit heavy equipment or rollers on completed surface. Do not permit vehicular traffic on surface for 24 hours after completion. Restore damaged pavement as directed by the Owner's Representative or the Architect, at no increase to contract sum.

#### **3.2 SUBGRADE PREPARATION**

- A. Paved Areas: Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Verify subgrade compaction and elevations and correct discrepancies before proceeding with base construction. Verify utility casting elevations and reset or adjust to meet flush with finished pavement surface. Do not place the base material/subbase material on frozen or muddy subgrade.

#### **3.3 SUBBASE COURSE**

- A. Place subbase course material on prepared subgrade in one uniform layer to depth required to produce compacted thickness indicated. Shape material, to sections and elevations indicated with blade grader and compact with pneumatic tired rollers to 100 percent maximum dry density. Control moisture content of the base course material to within 2 percent of optimum during compaction

operations. Compaction Standard: ASTM D 698. Proof roll subbase course with 8 ton tandem steel wheel roller and correct irregularities.

### 3.4 ASPHALT BASE COURSE

- A. Subbase Course Surface Preparation: Apply tack coat material to previously placed asphalt base course, existing pavement, curbing, utility castings and any structure abutting or projecting into paved area.
- B. Base Course Placement: Place asphalt in layers not exceeding four inches in compacted depth to total depth required to produce compacted thickness indicated. Place material with mechanical self-powered pavers capable of maintaining required line and grade. Place material by approved manual methods in areas inaccessible to self-powered pavers. The temperature of the material shall be not less than 225° F at the time of placement.
- C. Base Course Compaction: Compaction operations shall begin immediately following placement of the base course material, and shall consist of breakdown, intermediate and finish rolling. Material shall be compacted to in-place density of 92 to 97 percent of theoretical maximum density. In-place compaction shall be completed before the material cools below 185° F. Use self-powered tandem steel wheel rollers. Use power driven trench rollers in areas inaccessible to self-powered equipment. Begin rolling longitudinally at low side or edge and proceed toward high side or crown. Overlap successive roller trips one half-roller width. Do not terminate alternate roller trips at the same location. Continue finish rolling until 92 percent to 97 percent theoretical maximum density is obtained and all roller marks are eliminated. Density test method: AASHTO T 230.

### 3.5 ASPHALT SURFACE COURSE AND OVERLAY

- A. General: Provide overlay protective membrane treatment where indicated. Provide overlay protective membrane strips over all long, running cracks or pavement joints except in areas where overlay protective membrane is already indicated.
- B. Asphalt Base Course Surface Preparation: Remove loose material from surface before applying tack coat. Apply tack coat material uniformly to surface at a rate of 0.10 gallon per square yard. Allow tack coat to cure as long as required to properly set but not less than 12 hours.
- C. Existing Asphalt Pavement Preparation: Clean and dry pavement, with compressed air, removing debris, dust, foreign materials and moisture.
  - 1. Obtain pavement preparation approval, from the Architect prior to overlay binder coat application. Apply overlay binder coat material uniformly to prepared asphalt surface. Apply at a rate of 0.25 gallon per square yard. For long running cracks or joints in existing pavement surface where overlay protective membrane strips will be used, apply overlay

- binder coat material to a width of approximately two feet so as to span existing cracks or joints. Adjust application rate, based on existing pavement relative porosity, at no increase to contract sum. Apply overlay binder coat material at 300° F minimum to 350° F maximum.
2. Lay down overlay protective membrane, on cured overlay binder coat, in accordance with manufacturer's installation instructions and as noted. Transverse joint overlap to be 12 inches, "shingled" in the direction of paving to prevent edge pick-up by the pavers. Longitudinal joint overlap to be six inches. Cut and piece membrane to fit irregular shaped areas (e.g. access road intersections, curb returns, etc.). Obtain pavement preparation approval from the Owner's Representative or the Architect prior to tack coat application.
  3. Lay down overlay protective membrane strips on cured overlay binder coat, in accordance with manufacturer's installation instructions and as noted. Unroll overlay protective membrane strips, aligned with pavement joints, and seat in tacky overlay binder coat material by brooming, so as to span existing pavement joints. Blot excess overlay binder coat materials on the edges of the membrane strips with sand blanket. Cut and piece membrane to fit irregular shaped areas (e.g. access road intersections, curb returns, etc.). Obtain pavement preparation approval from the Owner's Representative or the Architect prior to tack coat application.
  4. Apply tack coat material uniformly to prepared asphalt surface. Apply at rate of minimum of 0.05 gallon per square yard and a maximum of 0.15 gallon per square yard. Tack coat to cure as long as required to properly set, but not less than 12 hours.
  5. Prepare existing asphalt pavement, as indicated and specified, at no increase to contract sum.
- D. Surface Course and Overlay Placement: Place asphalt, in one uniform layer, to depth required to produce the compacted thickness indicated. Place with mechanical self-powered pavers capable of maintaining required line and grade. Place and spread asphalt by approved manual methods in areas inaccessible to self-powered pavers. The temperature of the material shall be not less than 225° F at the time of placement.
- E. Surface Course and Overlay Compaction: Compaction operations shall begin immediately following placement of the surface course material, and shall consist of joint, breakdown, intermediate and finish rolling. In-place compaction shall be completed before the material cools below 185° F (85° C). Use power driven trench rollers in areas inaccessible to self-powered rollers. Begin rolling longitudinally at low side or edge and proceed toward high side or crown. Overlap successive roller trips, one-half roller width. Do not terminate alternate trips at same point. Continue finish rolling until 98 percent to 102 per-

cent theoretical maximum density is obtained and all roller marks are eliminated. Density test method: AASHTO T 230.

### 3.6 JOINT SEALING

- A. Completely seal and fill joints along existing and new pavement and curbing interface with joint sealant.

### 3.7 TESTING

- A. General: Correct work not conforming to specified tolerances as directed by the Owner's Representative or the Architect, at no increase to the contract sum.
- B. Thickness Tests: Conduct subbase, base and surface course thickness tests and provide test area restoration upon completion. Tolerance not less than 1/2 inch from compacted thickness indicated. Test locations are random and to be determined by the Owner's Representative or the Architect. Regardless of paved area size, at least one test shall be performed for each newly paved area.
- C. Smoothness Tests: Conduct surface course smoothness tests. Tolerance not to exceed 1/8 inch between any two surface contacts on 10-foot straightedge. Test locations are random and to be determined by the Owner's Representative or the Architect. Regardless of paved area size, at least one test shall be performed for each newly paved area.
- D. Laboratory Density Tests: Conduct subgrade, subbase and base course laboratory density tests. Density testing shall be performed by individuals certified to perform asphalt testing. Test method: ASTM D 1557. Test interval to be determined by the Owner's Representative or the Architect, but no less than one test for each newly paved area and/or one test per 1000 feet of roadway shall be performed.
  - 1. Provide test area restoration.
- E. Field Density Tests: Conduct subgrade, subbase and base course in-place field density tests. Density testing shall be performed by individuals certified to perform asphalt testing. Test method: ASTM D 1556 or D 2167. Test locations are random and to be determined by the Owner's Representative or the Architect, but no less than one test for each newly paved area and/or one test per 1000 feet of roadway shall be performed.
  - 1. Provide test area restoration.

### 3.8 CLEANING



- A. Clean improvements and facilities damaged by tack coat overspray as directed by the Owner's Representative or the Architect.

3.9 WASTE MANAGEMENT

- A. Recycle waste materials in accordance with Division 1 "Construction Waste Management" requirements.

**END OF SECTION**



**SECTION 32 1220****ROAD AND PARKING ACCESSORIES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials and work required to apply, install and construct miscellaneous road and parking accessories.

**1.3 RELATED WORK**

- A. Refer to Section 31 20 00 "Earthmoving", and Section 32 13 13 "Cement Concrete Paving".

**1.4 STANDARDS**

- A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction Materials".
- B. "Manual on uniform Traffic Control Devices for Streets and Highways" ANSI D6.1-1971.

**1.5 SUBMITTALS**

- A. Products:
  - 1. Submit manufacturer's specifications and application instructions for pavement marking paint.
  - 2. Submit manufacturer's descriptive literature for road and parking area signs.

**1.6 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Deliver paint to project site in original unopened containers bearing manufacturer's label.
- B. Store paint in tightly covered containers.

**1.7 PROJECT CONDITIONS**

- A. Maintain vehicular and pedestrian traffic during pavement marking operations. Do not apply paint when ambient air temperature is below 50 deg. F, relative

humidity exceeds 85%, wind exceeds 20 miles per hour or pavement surface temperature is below 50 deg. F.

- B. Curbs and line stripes at handicapped parking spaces shall be painted yellow.
- C. All other on-site striping shall be white.

**PART 2 - PRODUCTS****2.1 MATERIALS**

- A. Pavement Marking: AASHTO M 248, type I, non-reflective paint, colors as noted. Materials used in the Public Right-of-Way shall be Type B, Class I, Thermoplastic alkyd. Materials used in the Public Right-of-Way shall be approved by Montgomery County Department of Transportation, Traffic Engineering prior to installation. Colors shall be:
  - 1. Standard Parking Spaces: White
  - 2. Handicapped Parking Spaces Yellow
  - 3. Traffic Lanes: Yellow
- B. Curb Marking : AASHTO M 248, type I, reflective yellow paint.
- C. Road and Parking Area Signs: Obtain from Montgomery County Department of Transportation.
  - 1. Handicapped Parking Area: In accordance with Montgomery County Department of Transportation standards, and the MUTCD.
  - 2. Stop Signs shall be 30" by 30" signs.
- D. Traffic Control Signs:
  - 1. Traffic control signs in accordance with Montgomery County Department of Transportation standards, the MUTCD, and as indicated.
- E. Sign Posts: Galvanized steel channel with 5/16 by two inch steel nuts and bolts and galvanized steel washers.

**PART 3 - EXECUTION****3.1 PAVEMENT MARKING**

- A. Surface Preparation: Clean pavement surfaces, removing grease, oil, mud and foreign materials.
- B. Preparation for New Pavement Markings: Lay out markings to dimensions and line widths indicated and specified. Bituminous concrete pavement to cool and set five calendar days prior to paint application. Do not apply marking materials to wet or damp pavement surfaces. Do not apply marking materials until pavement marking removal paint has set and hardened. Surfaces to set an additional eight hours after appearing dry.
- C. Application: Thermoplastic pavement marking materials shall be applied to the pavement at a minimum temperature of 204 degrees Centigrade (400 degrees Fahrenheit). Apply paint to width and length of pavement marking lines indicated, and as noted. Apply paint with spray equipment and/or conventional traffic line striping equipment, and in accordance with paint manufacturer's recommendations, to produce markings parallel and with

sharp line edges, uniform in cross section and with line widths as indicated or specified. Minimum application rate to be 100 feet per gallon.

1. Layout and apply paint for universal handicapped space symbols in accordance with standard practice and as directed by the Architect or the Owner's Representative.
- D. Protection and Restoration: Protect completed paint marking from damage. Do not permit vehicular or pedestrian traffic on completed marking until paint has set and hardened. Restore damaged paint marking as directed by the Architect.

### 3.2 CURB MARKING

- A. Locations:
1. Montgomery County: Fire Marshal will tour site after completion of curbing and pavement construction. During tour Fire Marshal will indicate locations where curb marking is to be applied. Contractor shall apply markings at no increase to contract sum.
- B. Application: Allow concrete curbing to cure 14 calendar days prior to paint application. Clean curb surfaces removing grease, oil, mud and foreign material. Do not apply paint to wet or damp curb surfaces. Apply paint to face and top of curbing by manual brush methods or with spray equipment.

### 3.3 ROAD AND PARKING AREA SIGNS

- A. Sign Locations: Locations of various sign types shall be as indicated on Construction Drawings and as directed by the Owner and the Architect. Contractor shall provide and install indicated and selected signs at no increase to Contract Sum.
- B. Post Installation: Excavate post footing to 12 inch diameter and 30 inch depth. Place and consolidate concrete in footing excavation. Install post and assembled sign in concrete plumb to 1/4 inch in 10 feet and 24 inch depth. Provide bracing to prevent movement. Slope concrete surface one inch with outside edges flush with finished grade and trowel to smooth finish. Contractor shall allow concrete footings to cure a minimum of 14 calendar days before removing bracing.

**END OF SECTION**

**SECTION 32 1313****CEMENT CONCRETE PAVING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials and work required to construct Portland cement concrete walks and curbing.

**1.3 RELATED WORK**

- A. Refer to Section 31 20 00 "Earthmoving".

**1.4 STANDARDS**

- A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction and Materials".
- B. Montgomery County, Department of Transportation's current "Design Standards".

**1.5 SUBMITTALS**

- A. The contractor shall provide a sample of eight linear feet of typical concrete walk, with a control joint, for approval by the Owner's Representative. No additional concrete walk may be constructed until the sample is inspected and approved.
- B. Submit location of product manufacture and of extraction/recovery of primary raw materials.
- C. Submit cut sheets for construction of curb in the public right-of-way to and obtain approval from the governing jurisdiction and the Architect prior to curb construction.
- D. The contractor shall provide a sample of eight linear feet of typical concrete curb-and-gutter, with a control joint, for approval by the Owner's Representative. No additional concrete curbing may be constructed until the sample is inspected and approved.

- E. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.
- F. Submit documentation indicating Solar Reflectance Index (SRI) value.

## 1.6 PROJECT CONDITIONS

- A. Traffic: Maintain pedestrian traffic during walk construction operations.
- B. Limitations:
  - 1. Underground Utilities: Do not proceed with concrete construction until underground utility construction is complete.
  - 2. Curbing: Do not proceed with concrete walk construction until adjacent or adjoining curb construction is complete.
  - 3. Environmental: Refer to Section 33 10 00 "Utility Standards".

## 1.7 CONSTRUCTION SURVEYS

- A. Retain the services of a registered land surveyor or professional engineer to provide combined horizontal and vertical alignment stakes for curb construction within public right of way. Horizontal stake interval 25 feet maximum.
- B. Provide combined horizontal and vertical alignment stakes for project site curb construction. Horizontal stake interval 25 feet maximum.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. General: Provide products manufactured and of raw materials extracted/recovered within a 500-mile radius of the Project Site.
- B. Gravel Base: ASTM C 33 coarse aggregate, size number 6 (1" to No. 4).
  - 1. Contractor's Option: MDOT-SHA Coarse Aggregate No. 57 Stone.
  - 2. Recycled concrete RC-6 may, at Contractor's discretion, be used for base in approved locations.
- C. Concrete: Class "A" Portland cement concrete, Section 331000 "Utility Standards".
  - 1. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05
  - 2. Albedo: Concrete mix design, including cement and aggregate materials, shall achieve a minimum reflectance (albedo) of 0.3 when compared with tested values of mix designs included in Lawrence Berkeley National Laboratory's "Effects of Composition and Exposure On the Albedo of Portland Cement Concrete", Appendix A: Images and Albedos of All Concretes".



- D. Joint Materials: Expansion and Isolation Joints: ASTM D 994, bituminous pre-formed joint filler, 1/2 inch thick.
- E. Forms: Steel or wood for straight or tangent walks. Non-rented wood materials shall be FSC-certified sustainably harvested.
- F. Curing Materials: Burlap Mats: AASHTO M182, Class 1.
- G. Miscellaneous Products:
  - 1. Form Release Compound: Non-staining, zero-VOC, 100% biodegradable made from plant-based oils and approved by the Architect.
  - 2. Cement Mortar: Section 33 10 00 "Utility Standards".

### **PART 3 - EXECUTION**

#### **3.1 PROTECTION AND RESTORATION**

- A. Concrete: Protect completed concrete from damage. Restore damaged concrete as directed by the Owner's Representative or the Architect.

#### **3.2 SUBGRADE PREPARATION**

- A. Paved Areas: Section 31 20 00 "Earthmoving" and as noted. Verify subgrade elevations and compaction and correct discrepancies before proceeding with construction. Verify utility casting elevations and reset or adjust to meet flush with finished concrete surface. Remove loose material from subgrade prior to gravel base placement.

#### **3.3 GRAVEL BASE PLACEMENT**

- A. Place and compact gravel base on prepared subgrade to depth indicated. Remove debris from surface of gravel base prior to placement of concrete. Do not place gravel base material on frozen or muddy subgrade.

#### **3.4 FORMS**

- A. Clean and coat forms with form release compound, prior to use. Install forms to lines, grades and elevations indicated or as specified. Brace forms to prevent movement during concrete placement.

#### **3.5 EXPANSION JOINTS**

- A. Install expansion joints at maximum 25-foot intervals or as indicated. Install expansion joints, adjacent to curbing, opposite curbing joints and as indicated. Place expansion joints perpendicular to concrete surface and with top edge 1/4 inch below concrete surface.

#### **3.6 ISOLATION JOINTS**

- A. Install isolation joints where concrete abuts buildings, existing walk sections, utility structures and concrete curb. Place isolation joints with top edge 1/4 inch below concrete surface.

### 3.7 CONTRACTION JOINTS (SCORE LINES)

- A. Provide contraction joints at five-foot intervals or as indicated. Form contraction joints with 3/4 inch jointing tool.

### 3.8 CONCRETE PLACEMENT

- A. Sample Approval: No concrete walks may be constructed until the sample section has been inspected and approved by the Owner's Representative.
- B. General: Place concrete in forms in one uniform layer. Consolidate concrete by tamping, spading or vibrating to prevent honeycombing. Place and consolidate concrete carefully to prevent dislocation of joint materials.

### 3.9 FINISHING

- A. General: Draw a fine hair broom across concrete surface. Where longitudinal grade exceeds five percent, use a coarse texture finish by drawing a stiff bristle broom across concrete surface.
- B. Handicapped Ramps: Handicapped ramps shall have exposed aggregate (or other approved detectable) surface.
- C. Curbs: Strike off top surfaces of curbing to top of forms and to smooth and uniform texture. Strip curb face forms when concrete takes initial set. Trowel curb face to smooth and uniform texture. Finish top surfaces and curb face to fine texture by drawing a soft bristle brush longitudinally along curb. Finish edges of curbing with edging tool having a radius as indicated. Maintain forms, except curb face forms, in place 12 hours after concrete placement. Correct defects (e.g. holes, honeycomb areas, broken edges, etc.) upon removal of remaining forms, with cement mortar. Finish contraction joints with 1/4-inch radius edging tool. Finish curbing joints to clean and true edges. Maintain curbing surfaces moist during finishing operations.

### 3.10 CURING

- A. Mat Method: Moisten mats thoroughly with water before placing on exposed concrete surfaces and overlap six inches. Cover mats with polyethylene sheeting and maintain mats in continuously moist condition for seven calendar days. Repair or replace damaged mats.

### 3.11 TESTING

- A. General: Correct work not conforming to tolerances as directed by the Owner's Representative or the Architect, at no increase to the contract sum.

- B. Walk Horizontal Alignment Test: Tolerance not to exceed 1/2 inch between any two contacts on 10-foot straightedge, except along horizontal curves. Test locations random and determined by the Owner's Representative or the Architect. Test observation by the Owner's Representative or the Architect.
- C. Walk Surface Smoothness Test: Tolerance not to exceed 3/8 inch between any two surface contacts on 10-foot straightedge. Test locations random and determined by the Owner's Representative or the Architect. Test observation by the Owner's Representative or the Architect.

### 3.12 WASTE MANAGEMENT

- A. Recycle waste materials in accordance with Division 1 "Construction Waste Management" requirements.

**END OF SECTION**



**SECTION 32 3000****SITE AND STREET FURNISHINGS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following site and street furnishings:
  - 1. Bike Racks
  - 2. Benches.
  - 3. Trash receptacles.
- B. Related Sections include the following:
  - 1. Division 31 Section "Earthwork" for excavation for installation of concrete footings.
  - 2. Division 3 Section "Concrete" for formed voids in concrete footings.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, field-assembly requirements, and installation details.
  - 1. Submit location of product manufacture
  - 2. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.
- B. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
  - 1. Size: Not less than 6-inch- long linear components and 4-inch- square sheet components.
- C. Submit certificates, signed by Contractor, that the installers of the equipment and artificial turf systems that have a minimum of five (5) years experience in the installation of site and street furnishings as applicable.
- D. Product Schedule: For site furnishings. Use same designations indicated on Drawings.
- E. Material Certificates: For site furnishings, signed by manufacturers.
  - 1. Recycled plastic.
- F. Maintenance Data: For site furnishings to include in maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of site and street furnishings through one source from a single manufacturer.

#### 1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Bench Replacement Slats: Not less than two full-size units for each size indicated.
  - 2. Trash Receptacle Inner Containers: 1 full-size unit.

#### 1.6 WARRANTIES

- A. Provide Manufacturer's standard warranty on main support components to cover structural failure due to corrosion, deterioration or defects in workmanship.

#### 1.7 PRODUCT DELIVERY AND STORAGE

- A. Deliver and store site and street furnishings in a manner to prevent damage during handling and storage. Damaged items will be replaced at no increase to the Contract sum.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide the following products by or a comparable product by another manufacturer approved by Architect prior to bid, giving preference to products manufactured within a 500-mile radius of the Project Site.
  - 1. Bike Racks: Columbia Cascade Company; Model 2170-11-P-C.
  - 2. Bench: Victor Stanley, Inc.; Homestead Series Model 32.
  - 3. Trash Receptacles: Victor Stanley, Inc.; Model ES-242.

#### 2.2 MATERIALS

- A. Steel: Free from surface blemishes and complying with the following:
  - 1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - 2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53, or electric-resistance-welded pipe complying with ASTM A 135.
  - 3. Tubing: Cold-formed steel tubing complying with ASTM A 500.
  - 4. Sheet: Commercial steel sheet complying with ASTM A 569/A 569M.
- B. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.

1. Recycled Polyethylene: Fabricated from not less than 96 percent recycled, purified, fractional-melt plastic resin for not less than 90 percent recycled postconsumer waste by weight content HDPE.
- C. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality; tamperproof, vandal and theft resistant; concealed, recessed, and capped or plugged. Provide as required for site furnishings' assembly, mounting, and secure attachment.
- D. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

### 2.3 BIKE RACKS:

- A. Frame: Steel.
- B. Table Height: As indicated by basis-of-design product.
- C. Overall Width: 10 feet.
- D. Overall Depth: As indicated by basis-of-design product.
- E. Weight: As indicated by basis-of-design product.
- F. HDPE Color: As selected by Architect from manufacturer's full range.

### 2.4 BENCHES:

- A. Frame: Steel.
- B. Seat and Back: Plastic; formed from evenly spaced parallel slats.
- C. Arms: None.
- D. Seat Height: As indicated by basis-of-design product.
- E. Overall Width: 6 feet.
- F. Overall Depth: As indicated by basis-of-design product.
- G. Weight: As indicated by basis-of-design product.
- H. Seat Surface Shape: As indicated by basis-of-design product.
- I. HDPE Color: As selected by Architect from manufacturer's full range.

## 2.5 TRASH RECEPTACLES

- A. Materials: 3/8" x 1" vertical solid steel bar; 1/4" x 2-1/2" horizontal solid steel bands; 3/8" x 3" steel support bars; 5/8" solid steel top ring; 36 gallon capacity high density plastic liner; leveling feet with a 3/8" diameter threaded steel shaft
- B. Lids and Tops: Formed lid attached to the frame with two vinyl-coated steel aircraft cables.
- C. Style: As indicated by basis-of-design product.
- D. Weight: As indicated by basis-of-design product.
- E. Liners: High-density plastic liner.
- F. Capacity: Not less than 24 gal.
- G. Installation Method: Anchored to cast in place concrete.

## 2.6 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Steel and Iron Components: Galvanized, galvanized and color coated, or color coated. Bare metal steel or iron components are not permitted.
- E. Exposed Surfaces: Polished, sanded, or otherwise finished; smooth all surfaces, free from burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- F. Factory Assembly: Assemble components in the factory to the greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.



## 2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.8 STEEL AND GALVANIZED STEEL FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester-TGIC, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions, unless more stringent requirements are indicated. Complete field assembly of site and street furnishings, where required.
- B. Unless otherwise indicated, install site and street furnishings after landscaping and paving have been completed.
- C. Install site and street furnishings level, plumb, true, and securely anchored or positioned at locations indicated on Drawings.

## 3.3 CLEANING

- A. After completing site and street furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

**END OF SECTION**



**SECTION 32 3113****CHAIN LINK FENCES AND GATES****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- B. This Section includes the following:
  - 1. Materials and Work Required to Construct Chain Link Fence and Gates and Related Accessories.

**1.3 STANDARDS**

- A. Installation shall be per chain link manufacturer's standards (CLFMI).

**1.4 SUBMITTALS**

- A. Submit manufacturer's descriptive literature, specifications and installation instructions for chain link fence and gates.
  - 1. Include location of product manufacture.
- B. LEED Submittals: Product data for steel components indicating percentages of pre-consumer and post-consumer recycled content.
- C. Submit samples of vinyl-coated fabric 12 by 24 inches.
- D. Warranty:
  - 1. Submit typewritten vinyl coated fence warranty signed by manufacturer and contractor.

**1.5 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Deliver chain link fencing to the project site in original unopened containers bearing manufacturer's label.

**1.6 QUALITY ASSURANCE**

- A. Provide complete fencing (of each type) produced by a single manufacturer.

**1.7 PROJECT CONDITIONS**

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.

- B. Limitations: Do not proceed with fencing installation until underground utility, bituminous concrete pavement and concrete curb and gutter construction is complete.

## 1.8 WARRANTY

- A. Warrant vinyl coated fencing for 10 years against peeling, cracking and corrosion.

## 1.9 CONSTRUCTION SURVEYS

- A. Retain the services of a registered land surveyor or professional engineer to provide horizontal alignment stakes for fencing located adjacent to site property lines. Horizontal stake interval 50 feet maximum, and at all angle points along property line.
- B. Provide horizontal alignment stakes for project site fencing. Horizontal stake interval 50 feet maximum and at all corner points.

## PART 2 – PRODUCTS

### 2.1 CHAIN LINK FENCING

- A. Acceptable Manufacturers, giving preference to products manufactured within a 500-mile radius of the Project Site:
  - 1. Anchor Fencing
  - 2. Sonco Fence
  - 3. Long Fence
  - 4. P&H Tube Division/Southwestern Pipe
  - 5. Allied Tube and Conduit Corp.
  - 6. Other pre-bid approved manufacturer(s) meeting the requirements of this Specification Section will be considered in accordance with Specification Section 01630: Substitutions and Product Options.
- B. General: Posts, rails, braces and bracing assemblies shall be high tensile steel pipe, cold-rolled and electric resistance welded from steel conforming to ASTM A 569, and hot-dip galvanized to ASTM A 525 G-90 zinc weight both inside and outside the pipe.
- C. Finish: The outsides shall receive a conversion coating and fusion bonded polyester powder coating equivalent to "Lifecoat LCX" by P & H Tube. Coating color shall be black.
  - 1. All fencing except Multipurpose Court shall have bottom tension wire.
  - 2. All fencing shall have continuous top rail.
- D. Fabric: 9-gauge (0.148-inch) core size, finished steel wires, galvanized in accordance with ASTM A 641-71a. Finish shall be thermally bonded PVC over galvanized steel, Class 2B, in accordance with ASTM F 668. Coating color shall be black. Fabric shall have 2-inch diamond mesh pattern with top and bottom selvages knuckled.

- E. Multipurpose Court Fencing: Mesh size shall be 1-3/4 inches. All court fencing shall have top rail and bottom rail.
- F. Posts, Rails and Braces
  - 1. Terminal Posts (Corner Posts): Up to 6 feet: 2.375 inch O.D.; over 6 feet: 2.875 inch O.D..
  - 2. Line Posts: Up to 6 feet: 1.90 inch O.D.; over 6 feet: 2.375 inch O.D..
  - 3. Gate Posts (Hinge Posts): Leaf widths up to 6 feet: 2.875 inch O.D.; leaf widths 6 feet to 13 feet: 4.00 inch O.D.
  - 4. Top Rail and Bottom Rail: Manufacturer's longest lengths, with expansion couplings (approximately 6 inches long) for each joint. Provide means of attaching top rail securely to each corner, end, and pull post.
  - 5. Terminal and Gate Post Bracing Assemblies: Manufacturer's standard adjustable brace at end posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for braces. Brace line posts with 0.375-inch diameter rod and adjustable tightener.
  - 6. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross section of 3/16" x 3/4". Provide one stretcher bar at each end post and two for each corner and pull post, except where fabric is integrally woven into post.
- G. Gates
  - 1. Gate framing shall be 2-inch square aluminum tube with fabric installed inside the frame with "J" bolts.
  - 2. Hinges shall be manufacturer's standards.
  - 3. Latches shall be butterfly type.
  - 4. Height shall match adjacent fencing fabric, leaf swings 180 degrees.
- H. Bottom Tension Wire: 7-gauge, O.D. = 0.177-inch core size, with PVC coating.
- I. Post Tops (Caps): Weathertight closure caps, dome type, at each post, with openings to permit passage of top rails.
- J. Hardware and Accessories: Galvanized per ASTM A 152 with manufacturer's standard polyvinyl chloride (PVC) plastic resin finish over galvanizing, not less than 10 mils (0.010") thick.
- K. Electrical Grounds: Provide at least one (1) electrical ground for each 1,000 ft. of fence, located near the center of the run. Provide additional grounds directly under the point where power lines pass over the fence. Vertically drive or drill in the grounding rod until the top of the rod is approximately 6 in. below the top of the ground. Connect a No. 6 solid copper conductor to the rod and to the fence by a UL-listed method so that each element of the fence is grounded.

## 2.2 CHAIN LINK FENCING HEIGHTS

- A. Heights shall be as indicated or as specified:

### 2.3 PADLOCKS

- A. Padlocks manufactured by Master Lock Company, Milwaukee, Wisconsin. Provide one "Steel Secret Service" lock and furnish Owner with two keys for each gate.

### 2.4 CONCRETE

- A. Class "B" Portland cement concrete, Specification Section 33 10 00: Utility Standards.

## PART 3 - EXECUTION

### 3.1 PROTECTION AND RESTORATION

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Existing Utilities: Verify utility locations prior to fencing excavation operation. Adjust horizontal fencing alignment to avoid utilities at no increase to contract sum.

### 3.2 GRADING

- A. Grade fence lines to smooth and uniform surfaces, free of depressions and high spots exceeding four inches in ten feet.

### 3.3 CHAIN LINK FENCING

- A. General: Install in accordance with manufacturer's installation instructions and as noted. Install corner posts at horizontal alignment changes exceeding 30 degrees. Install line posts at intervals not exceeding ten feet. Install gateposts on both sides of gate opening.
- B. Post Installation:
  - 1. Excavate post footings to minimum 18-inch diameters and 39 inch depths or as otherwise indicated.
  - 2. Place and consolidate concrete in footing excavations. Install posts in concrete plumb to 1/4 inch in 10 feet. Provide bracing to prevent movement. Embed line post in concrete to 18 inches, terminal and gate posts to 24 inches. Slope exposed concrete footing surface one inch with outside edge flush with ground surface. Trowel exposed concrete footing surface to smooth finish. Contractor shall allow concrete footings to cure a minimum of 14 calendar days before removing bracing, or performing subsequent fencing operations.

- C. Terminal and Gate Post Bracing Assemblies, Truss Rods and Tighteners and Tension Wire and Post Tops: Install in accordance with manufacturer's installation instructions and as specified.
- D. Fabric: Each span shall be attached independently at pull and corner posts. Ends of fabric rolls and other section to be spliced shall be joined by weaving a single strand of the fabric wire into ends of the fabric to create a continuous pattern of mesh. Fabric shall be stretched taut and securely fastened to each post and rail. Fastenings at ends, gates, corners, and pull posts shall be with stretcher bars and metal bands.

### 3.4 MAINTENANCE

- A. Refer to Section 31 20 00 "Earthmoving".

**END OF SECTION**





**SECTION 323120**  
**METAL PANEL GATES**

**PART 1 - GENERAL****1.1 SUMMARY**

- A. The extent and locations of metal gates are shown on the Contract Drawings, and include devices for anchorage of gates to substrates.
- B. Related Sections:
  - 1. Division 03 - Concrete Section
  - 2. Section 087100 - Door Hardware: Padlocks and provisions for masterkeying.

**1.2 SUBMITTALS**

- A. General: Submit in accordance with Section 013300.
- B. Product Data: Submit product data for each component, including each type and grade of metal used in fabricating units, and for bolts and accessory items used in assembly and installation. Include manufacturer's product data for materials to be used in finishing or painting gate units.
- C. Shop Drawings: Indicate layout, grid, spacing of components, gate openings, accessories, fittings, and anchorage. Show typical plan, elevation, and section of units, including bracing and joint/anchorage details. Include details of gate posts, corners and terminations.
- D. Informational Submittals: Submit following:
  - 1. Certifications specified in Quality Assurance article.
  - 2. Qualification Data: Manufacturer's and installer's qualification data.
  - 3. Manufacturer's instructions.

**1.3 QUALITY ASSURANCE**

- A. Single Source Responsibility: Provide metal gates as complete units controlled by single source including necessary accessories, fittings, and fastenings.
- B. Manufacturer Qualifications: Minimum three years experience in production of metal gates.
- C. Certifications: Manufacturer's certification that products furnished for Project meet or exceed specified requirements.

**1.4 DELIVERY, STORAGE AND HANDLING**

- A. Comply with requirements of Section 016000.

**PART 2 - PRODUCTS****2.1 MATERIALS**

- A. Materials, General:
  - 1. Steel shapes, plates, and bars: ASTM A36
  - 2. Steel Structural Tubing: ASTM A618; welded or seamless, high-strength, low alloy, structural tubing; shapes/sizes as indicated.
  - 3. Welded Rods and Bare Electrodes: Provide as required by AWS specifications, for the metal and alloy to be welded.
  - 4. Bolts and Fasteners: ASTM A320, AISI Type 300-series, stainless steel bolts and nuts. Where within reach from street-face of gate, provide non-removable bolt/nut units (not removable by use of commonly available tools). Provide stainless steel washers.
  - 5. Concrete Inserts: Furnish anchorage units to be placed in concrete substrate; of hot-dip galvanized cast-iron/malleable-iron body, design as indicated: ASTM A153 zinc coating, ASTM A47 casting.
  - 6. Setting/Anchoring Cement: Nonshrinking, nonstaining, hydraulic-controlled expansion cementitious compound; factory prepackaged for mixing with water at project site for a pourable and trowellable mix; recommended by manufacturer for exterior exposure without protective coating, sealer, or waterproofing.

7. Expansion Shims: To allow for thermal expansion of gate units, provide fluorocarbon resin (or similar) plastic washers, pads, and slip sheets in bolted connections between units and between gate components and anchorages.
- B. Metal Gates
  1. Gate Frames: Fabricate swing gate using steel members.
  2. Bracing: Provide diagonal truss brace as necessary on large gates to prevent sag.
  3. Hardware Materials: Galvanized steel, aluminum, or malleable iron shapes to suit gate size for cane bolts, padlock hasps.
  4. Corrugated metal deck: Galvanized, 22 gage minimum.
  5. Hinges: Structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 95 degrees minimum.
- C. Accessories: Items necessary to achieve complete assembly and appearance depicted on Drawings.

## **2.2 FABRICATION**

- A. General:
  1. Cut and form/shape members to sizes and shapes required, for assembly of gate units of sizes indicated.
  2. Weld joints of assembly with welds all around, to produce joints of full-member-strength, with no possible moisture penetration.
  3. Grind welds reasonably smooth, but not necessarily flush. Prefabricate units in plant by welding, to the greatest extent possible.
  4. Provide bolted connections for bracing elements and similar parts, but only to extent units must be disassembled for delivery to project and for installation by method indicated.
- B. Drill anchor bolt holes accurately spaced as shown, oversized by 1/4 in. above bolt size, for installation tolerance.
  1. Provide for thermal movement of units, amounting to plus-or-minus 1/8" in 10 ft. of gate length.
  2. Close ends of hollow members (pipes/tubes) which are not butt welded tight against another member in the assembly. Close with 1/4 in. thick steel plate, slightly recessed and welded all around for tight seal, except as otherwise shown.
  3. Avoid the use of bolts and screws exposed to and accessible from the street side of gate. Where unavoidable, provide nonremovable type fasteners in the assembly.
  4. Ease exposed metal edges of fabricated units, to approximately 1/32" in. radius, prior to finishing.

## **2.3 ZINC-RICH PRIMER**

- A. Inorganic, zinc-rich, capable of providing sound foundation for field applied top coats despite prolonged exposure, cathodic protection and corrosion resistance. Similar to galvanizing.
- B. Pigment Content: Minimum 80 percent zinc in dry film by weight.
- C. Maximum Allowable Dry Time: 1 hour to touch; 12 hours to top coat.
- D. Compatible with finish paint system specified in 099000.
- E. Acceptable Products:
  1. Tnemec H90-97 Tneme-Zinc, Tnemec Co., Kansas City, MO.
  2. Carbo-Zinc 859 VOC, Carboline Company, St. Louis, MO.
  3. ZRC Cold Galvanizing Compound, ZRC Products Company, Quincy, MA.

## **2.4 FINISH**

- A. Exterior Gates: Zinc-Rich primer.
  1. Provide final painting under Section 099000.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine conditions and proceed with work in accordance with Section 017300.
  - 1. Coordinate gate installation with work of others sections of these specifications.
  - 2. Coordinate with concrete reinforcement placement.
  - 3. Check concrete substrate and anchorage inserts, for compliances and tolerances required to facilitate installation of gate units. Coordinate beginning of installation with curing of concrete substrate, and with other work at project site.

**3.2 INSTALLATION**

- A. Excavation: Drill holes in concrete for posts of diameters and spacings indicated in firm, undisturbed or compacted soil in accordance with manufacturer's instructions.
  - 1. Excavate hole depths approximately 6 inches minimum lower than post bottom with bottom of posts set not less than 36 inches minimum below finish grade surface.
  - 2. Excavate hole to minimum of 4 times largest cross-section of post.
  - 3. Setting Posts: Center and align posts in holes 6 inches minimum above bottom of excavation.
  - 4. Center posts in sleeves and grout solid when set in concrete structures.
- B. Touch up zinc rich primer where scratched or cutting and welding was required in the field.
- C. Gate Installation:
  - 1. Install gates plumb, level and secure for full opening without interference.
  - 2. Attach hardware by means which will prevent unauthorized removal.
  - 3. Adjust hardware for smooth operation and lubricate where necessary.

**3.3 CLEANING**

- A. Touch-Up Painting:
  - 1. Perform immediately after erection.
  - 2. Clean field welds of flux.
  - 3. Power-tool clean abraded shop paint.
  - 4. Paint exposed areas with zinc-rich shop primer.

**3.4 PROTECTION**

- A. Protect gates under provisions of Section 017300.

**END OF SECTION**



**SECTION 32 9000****TREE CONSERVATION****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies labor, materials, and equipment and services necessary for and reasonably incidental to preservation, protection and care of trees as shown on the Drawings, specified or directed.

**1.2 DEFINITIONS**

- A. Caliper: Diameter of a trunk measured by a diameter tape at 6 inches above the ground for trees up to, and including, 4-inch size; and 12 inches above the ground for trees larger than 4-inch size.
- B. Plant Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on drawings.
- C. Tree Protection zone: Area surrounding individual trees or groups of trees to remain during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated. Additional tree protection zones are those areas enclosed by tree protection fence, installed in the location and manner shown on the plans.
- D. Vegetation: Trees, shrubs, groundcovers, grass and other plants.

**1.3 QUALITY ASSURANCE**

- A. Methods for tree preservation and protection shall conform to details shown on the Drawings and any pertinent nationally recognized standards.
- B. The Contractor shall during pre-construction activities, construction activities and post-construction activities employ an ISA (International Society of Arboriculture) certified arborist and Licensed Tree Expert with a minimum of two years experience in tree preservation. The Contractor shall submit documentation that arborist has the above qualifications.
- C. Pre-Construction Conference: Conduct conference at Project Site.
  - 1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
    - a. Construction Schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
    - b. Enforcing requirements for protection zones.
    - c. Arborist's responsibility.
    - d. Field quality control.

- D. The arborist shall be on-site at any time work is being performed in the vicinity of trees to supervise implementation of procedures for tree protection, to monitor tree health during construction operations and the installation of pipes, curbs, sidewalks, etc and to supervise any repair of damages after construction.
- E. All work must be contained within the prescribed limits of disturbance shown on the contract documents.

#### 1.4 PROJECT CONDITIONS

- A. The following conditions are prohibited within protection zones:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Foot traffic.
  - 4. Erection of sheds or structures.
  - 5. Impoundment of water.
  - 6. Excavation or other digging unless otherwise indicated.
  - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames ignition sources, and smoking within or near protection zoned and mulch.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of the following:
  - 1. Protection Zone Fencing: Assembled Samples of manufacturers standard size made from full size components.
  - 2. Protection Zone Signage: Full-size samples of each size and text, ready for installation.
- C. Tree pruning schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.
- D. Qualification Data: For qualified arborist and tree service firm.
- E. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- F. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the work.
- G. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities:

1. Use sufficiently detailed photographs.
  2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- H. Provide written report by a certified arborist identifying root evaluations of the trees, which are in potential conflict with construction to determine the critical root zones.
- I. Provide written report by a certified arborist indicating the best methods of construction, which will minimize the impact on the critical root zone. Obtain specifications from the arborist for individual tree protection and maintenance as required for the identified to be saved on the Drawings.

## **PART 2 - PRODUCTS**

### **2.1 TREE PROTECTION DEVICE**

- A. Fencing shall be tenax alpi or approved equal. It shall be wire mesh at least forty-eight (48) inches in height, with grid openings not greater than three (3) inches in width. Refer to approved Forest Conservation Drawings.

### **2.2 PROTECTION ZONE SIGNAGE**

- A. Shop fabricated, rigid plastic or metal sheet with attachment hold prepunched and reinforced; legibly printed with nonfading lettering and as follows:
1. Size and text: As shown on drawings.

### **2.3 SOIL AMENDMENTS**

- A. Suitable organic matter shall be peat moss, composted manure, deactivated sewage sludge or similar material as approved by the arborist or engineer.
- B. Special soil mixture is composed of one part suitable organic matter and 6 parts backfill. Backfill material shall be loose, fine, friable, even textured loam. The mixture shall not contain any rock fragments larger than four (4) inches in any direction, nor construction debris of any sort.
- C. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of weeds, roots, and toxic and other nonsoil materials.
1. Obtain topsoil only from well-drained sites where topsoil is 4 inches deep or more; do not obtain from bogs or marshes.
  2. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
  3. Type: Shredded hardwood
  4. Size Range: 3 inches maximum, ½ inch minimum
  5. Color: Natural

## **PART 3 - EXECUTION**

### 3.1 PRECONSTRUCTION ACTIVITIES

- A. The limits of disturbance shall be located and flagged by the Contractor in the field prior to any stress reduction or construction activities. Limits of Disturbance shall be placed outside of critical root zones of trees to be preserved wherever possible.
- B. As shown on the plans, trees which are to be preserved shall have their roots pruned. Root pruning trenches shall be located within one foot of limits of disturbance. Roots shall be cleanly cut to a depth of at least 24 inches using a vibratory plow (cable laying machine), tooth-chain trencher or other acceptable equipment. Fill trench as soon as possible with soil mixture herein described and pack to eliminate air pockets.
- C. Crown pruning: Prune branches that are affected by temporary and permanent construction. Prune branches as shown on Drawings and as follows:
  - 1. Pruning Standards: Prune trees according to ANSI A300 (Part 1)
  - 2. Do not apply pruning paint to wounds.
  - 3. Chip removed branches and dispose of offsite unless directed by MNCPPC Inspector otherwise.
- D. Fertilize trees in construction area at the rate of 3 pounds of nitrogen per 1000 square feet of root zone disturbed. Apply fertilizer to entire critical root zone out to root pruning trench. Fertilizer should be at least 50 percent (50%) slow release nitrogen and contain other essential elements and micronutrients.
- E. Water critical root zone immediately after applying fertilizer to saturate the top 6 inches of soil.
- F. Mulch 2-4 inches deep comprised of weed-free straw, woodchips, shredded bark or leaves shall be applied in the critical root zone adjacent to the pruning trench. Mulching shall not extend farther than 20 feet from the pruning trench.
- G. Trees which are dead or dying or are in poor condition prior to the start of construction shall be flagged and recorded on the plan.
- H. Wire Mesh Fence
  - 1. All tree Preservation Areas shall be surrounded by wire mesh fences per plans.
  - 2. Boundaries of fencing shall be staked, flagged and approved prior to installation.
  - 3. All fencing shall be installed prior to construction activities.
  - 4. Fences shall be firmly anchored at a spacing no greater than eight (8) feet and constructed in a manner which precludes sagging.
  - 5. All fencing shall be maintained in a good condition and promptly repaired or restored as the situation warrants.
  - 6. Signage per plans shall be securely fastened to fence.

### 3.2 CONSTRUCTION PHASE



- A. Any on-site decisions regarding conditions or activities which may be injurious to the health of certain specimen trees in the vicinity of the construction area shall be made in consultation with the specified arborist.
- B. Excavated and backfill material shall not be placed or side cast within the critical root zones of trees to be preserved.
  - 1. Redirect roots in backfill area where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.
  - 2. Do not allow exposed roots to dry out before placing in permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
- C. Construction equipment shall not be driven into or through protected trees, nor shall swinging cranes or backhoes be allowed in their canopies.
- D. There shall be no stacking or storing supplies within the critical root zones of trees to be preserved.
- E. Trees to be removed shall be taken out without damaging protected trees.
- F. There shall be no burning in or close to protected trees.
- G. Changing site grades which will cause drainage to flow into, or to collect near protected trees shall be prohibited. All grading shall take place outside the critical root zone of the trees to be protected.
- H. All equipment shall be kept outside the blaze orange fencing.
- I. In the event of drought, the protected trees shall be monitored for signs of stress and watered as needed or as directed by the arborist.
- J. The certified arborist shall also monitor trees to be preserved for any other conditions or activities not mentioned above which may be injurious to their health.

### 3.3 POST-CONSTRUCTION ACTIVITIES

- A. Repair & Care of Tree Damages
  - 1. The ends of any additional roots damaged or cut during the construction phase of the project which have not already been pruned and dressed at the outset of the project shall be cut off smoothly. Then peat moss or other suitable organic matter shall be added to the backfill material at a ratio of 1 part organic matter to 6 parts backfill. Fill and pack around roots to avoid air spaces. Restore grades to preconstruction elevations.
  - 2. Damaged limbs and dead limbs shall be removed if a safety hazard or if injurious to the health of the tree. Tree crown reduction procedures may

be employed to promote the health of a tree and shall be performed by a certified arborist.

3. If a tree is wounded during construction, under direction of the arborist, wounds should be cleaned, torn bark cut, and if possible the wounds dressed in a shape like a vertical ellipse, to facilitate rapid healing. Pruning knife shall be sharp and clean.
4. Unless directed otherwise by the arborist, any compacted soil within the critical root zone of the trees to be preserved shall be mechanically aerated to a depth of eight (8) inches. Aeration holes should be spaced one foot on center and should be positioned to avoid severing major roots.
5. The arborist shall inspect and review the trees within one-year after completion of construction and determine if the trees can be safely fertilized. The arborist shall make the initial fertilizer application and provide written instructions and information to the owner on successive fertilizer applications. After completion of construction the arborist shall perform Class II pruning on all trees to remove any damaged, dead, interfering and objectionable limbs ½ inch in diameter and larger. The arborist shall selectively thin the trees to properly shape the canopy, reduce wind resistance and the possibility of storm damage.

#### 3.4 REMOVAL OF TEMPORARY STRUCTURES

- A. Remove wire mesh fencing upon final approval from MNCPPC Inspector.
- B. Re-seed or sod disturbed areas in accordance with the Contract Documents.

**END OF SECTION**

**SECTION 32 9305****LAWNS AND GRASSES****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Fine grading and preparing lawn areas.
  - 2. Furnishing and applying new topsoil.
  - 3. Furnishing and applying soil amendments.
  - 4. Furnishing and applying fertilizers.
  - 5. Seeding new lawns.
  - 6. Sodding new lawns.
  - 7. Reconditioning existing lawn areas.
  - 8. Replanting unsatisfactory or damaged lawns.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 31 Section "Clearing" for protection of existing trees and planting, topsoil stripping and stockpiling, and site clearing.
  - 2. Division 31 Section "Earthmoving" for excavation, filling, rough grading, and subsurface aggregate drainage and drainage backfill.

**1.3 SUBMITTALS**

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division
  - 1. Specification Sections.
- B. Product data for the following:
  - 1. Aluminum sulfate.
  - 2. Fertilizers.
- C. Submit location of product manufacture and of extraction/recovery of primary raw materials.
- D. Certification of grass seed from seed vendor for each grass-seed mixture stating the botanical and common name and percentage by weight of each species and

variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for sod, identifying sod source, including name and telephone number of supplier.
- E. Certification by product manufacturer that the following products supplied comply with requirements:
  1. Limestone.
  2. Fertilizers.
- F. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of architects and owners, and other information specified.
- G. Material test reports from qualified independent testing agency indicating and interpreting test results relative to compliance of the following materials with requirements indicated.
  1. Analysis of existing surface soil.
  2. Analysis of imported topsoil.
- H. Planting schedule indicating anticipated dates and locations for each type of planting.
- I. Maintenance instructions recommending procedures to be established by Owner for maintenance of landscaping during an entire year. Submit before expiration of required maintenance periods.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful grass establishment.
  1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that grass planting is in progress.
- B. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- C. Topsoil Analysis: Furnish a soil analysis made by a qualified independent soil-testing agency stating percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and any limestone, aluminum sulfate, or other soil amendments to be added to produce a satisfactory topsoil.

- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.
- B. Sod: Harvest, deliver, store, and handle sod according to the requirements of the American Sod Producers Association's (ASPA) "Specifications for Turfgrass Sod Materials and Transplanting/Installing."

#### 1.6 COORDINATION AND SCHEDULING

- A. Planting Season: Sow lawn seed and install sod during normal planting seasons for type of lawn work required. Correlate planting with specified maintenance periods to provide required maintenance from date of Substantial Completion.
- B. Weather Limitations: Proceed with planting only when existing and forecast weather conditions are suitable for work.

#### 1.7 MAINTENANCE

- A. Begin maintenance of lawns immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
  1. Seeded Lawns: 60 days after date of Substantial Completion.
    - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established at that time, continue maintenance during next planting season.
  2. Sodded Lawns: 30 days after date of Substantial Completion.
- B. Maintain and establish lawns by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
  1. Replant bare areas with same materials specified for lawns.
  2. Add new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.
- C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawns uniformly moist to a depth of 4 inches.

1. Lay out temporary lawn-watering system and arrange watering schedule to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly seeded, plugged, or sprigged areas.
  2. Water lawn at the minimum rate of 1 inch per week.
- D. Mow lawns as soon as there is enough top growth to cut with mower set at specified height for principal species planted. Repeat mowing as required to maintain specified height without cutting more than 40 percent of the grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain following grass height:
1. Mow grass from 2 to 3 inches high.
- E. Postfertilization: Apply fertilizer to lawn after first mowing and when grass is dry.
1. Use fertilizer that will provide actual nitrogen of at least 1 lb per 1000 sq. ft. of lawn area.

## PART 2 - PRODUCTS

### 2.1 GENERAL:

- A. Provide products manufactured and harvested within 500 miles of project site.

### 2.2 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts' "Rules for Testing Seeds" for purity and germination tolerances. Seed mixes or blends are common in the northern and transition zones. Single-grass-species seed is common in the South.
1. Seed Mixture: Provide seed of grass species and varieties, proportions by weight, and minimum percentages of purity, germination, and maximum percentage of weed seed as indicated on Schedules at the end of this Section. Seed mixtures vary by region and year depending on availability and current state or local recommendations.

### 2.3 SOD

- A. Sod: Certified turfgrass sod complying with ASPA specifications for machine-cut thickness, size, strength, moisture content, and mowed height, and free of weeds and undesirable native grasses. Provide viable sod of uniform density, color, and texture of the following turfgrass species, strongly rooted, and capable of vigorous growth and development when planted. TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, 4 percent organic material minimum, free of stones 1 inch or larger in any dimension, and other extraneous materials harmful to plant growth.
  - 1. On-Site Topsoil Source: Reuse surface soil stockpiled on the site. Verify suitability of surface soil to produce topsoil meeting requirements and amend when necessary. Supplement with imported topsoil when quantities are insufficient. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.
  - 2. Off-Site Topsoil Source: Import topsoil from off-site sources. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes. Contractor's option: Amend existing surface soil to produce topsoil. Supplement with imported topsoil when required.

## 2.5 SOIL AMENDMENTS

- A. Lime: ASTM C 602, Class T, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent, with a minimum 99 percent passing a No. 8 sieve and a minimum 75 percent passing a No. 60 sieve.
  - 1. Provide lime in the form of dolomitic limestone.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Sand: Clean, washed, natural or manufactured sand, free of toxic materials.
- D. Perlite: Horticultural perlite, soil amendment grade.
- E. Peat Humus: Finely divided or granular texture, with a pH range of 6 to 7.5, composed of partially decomposed moss peat (other than sphagnum), peat humus, or reed-sedge peat.
- F. Retain above or below when humus is required or add requirements for other preferred humus materials.
- G. Sawdust or Ground-Bark Humus: Decomposed, nitrogen-treated, of uniform texture, free of chips, stones, sticks, soil, or toxic materials.
  - 1. When site treated, mix with at least 0.15 lb of ammonium nitrate or 0.25 lb of ammonium sulfate per cu. ft. of loose sawdust or ground bark.
- H. Manure: Well-rotted, unleached stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

- I. Herbicides: EPA registered and approved, of type recommended by manufacturer.
- J. Water: Potable.

## 2.6 FERTILIZER

- A. Bonemeal: Commercial, raw, finely ground; minimum of 4 percent nitrogen and 20 percent phosphoric acid.
- B. Superphosphate is an inorganic, neutral source of phosphorus, useful in alkaline calcareous soils of arid areas.
- C. Superphosphate: Commercial, phosphate mixture, soluble; minimum of 20 percent available phosphoric acid.
- D. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea-form, phosphorous, and potassium in the following composition:
  - 1. Composition: 1 lb per 1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- E. Slow-Release Fertilizer: Granular fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Slow-release fertilizer composition in subparagraphs below are examples only. Revise to suit Project. When used as a soil amendment, revise fertilizer mix to remedy deficiencies found in soil tests.
  - 2. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
  - 3. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

## 2.7 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Peat mulch may be required if seeded lawns are subjected to hot, dry weather or drying winds within 30 days of planting. Delete if not required.
- C. Peat Mulch: Provide peat moss in natural, shredded, or granulated form, of fine texture, with a pH range of 4 to 6 and a water-absorbing capacity of 1100 to 2000 percent.



- D. Fiber mulch and tackifiers below are used primarily to protect seeded or hydroseeded lawn areas from wind erosion.
- E. Fiber Mulch: Biodegradable dyed-wood cellulose-fiber mulch, nontoxic, free of plant growth- or germination-inhibitors, with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- F. Asphalt Emulsion Tackifier: Asphalt emulsion, ASTM D 977, Grade SS-1, nontoxic and free of plant growth- or germination-inhibitors.
- G. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application, nontoxic and free of plant growth- or germination-inhibitors.

## 2.8 EROSION-CONTROL MATERIALS

- A. Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, 0.92 lb per sq. yd. minimum, with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseed overspraying.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

### 3.3 PLANTING SOIL PREPARATION

- A. Limit subgrade preparation to areas that will be planted in the immediate future.

- B. Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter.
- C. Mix soil amendments and fertilizers with topsoil at rates indicated. Delay mixing fertilizer if planting does not follow placing of planting soil within a few days. Either mix soil before spreading or apply soil amendments on surface of spread topsoil and mix thoroughly into top 4 inches of topsoil before planting.
  - 1. Mix lime with dry soil prior to mixing fertilizer.
- D. Spread planting soil mixture to depth required to meet thickness, grades, and elevations shown, after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen.
  - 1. Place approximately 1/2 the thickness of planting soil mixture required. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil mixture.
  - 2. Delete subparagraph below if no sodded lawns.
  - 3. Allow for sod thickness in areas to be sodded.
- E. Preparation of Unchanged Grades: Where lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare soil as follows:
  - 1. Remove and dispose of existing grass, vegetation, and turf. Do not turn over into soil being prepared for lawns.
  - 2. Till surface soil to a depth of at least 6 inches (150 mm). Apply required soil amendments and initial fertilizers and mix thoroughly into top 4 inches of soil. Trim high areas and fill in depressions. Till soil to a homogenous mixture of fine texture.
  - 3. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
  - 4. Remove waste material, including grass, vegetation, and turf, and legally dispose of it off the Owner's property.
- F. Grade lawn and grass areas to a smooth, even surface with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future. Remove trash, debris, stones larger than 1-1/2 inches in any dimension, and other objects that may interfere with planting or maintenance operations.
- G. Moisten prepared lawn areas before planting when soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- H. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

### 3.4 SEEDING NEW LAWNS

- A. Sow seed with a spreader or a seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in 2 directions at right angles to each other.
  - 1. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
- B. Sow seed at the rates shown on drawings:
- C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
- D. Retain applicable protection paragraphs below. Correlate erosion-control materials with slope ratios and revise as necessary to suit Project.
- E. Protect seeded slopes exceeding 1:4 against erosion with erosion-control blankets installed and stapled according to manufacturer's recommendations.
- F. Protect seeded slopes exceeding 1:6 against erosion with jute or coir-fiber erosion-control mesh installed and stapled according to manufacturer's recommendations.
- G. Delete paragraph above and retain paragraph below if protection is required for all seeded areas.
- H. Protect seeded areas with slopes less than 1:6 against erosion by spreading straw mulch after completion of seeding operations. Spread uniformly at a minimum rate of 2 tons per acre to form a continuous blanket 1-1/2 inches loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
  - 1. Anchor straw mulch by spraying with asphalt-emulsion tackifier at the rate of 10 to 13 gal. per 1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

### 3.5 HYDROSEEDING NEW LAWNS

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.
  - 1. Mix slurry with nonasphaltic tackifier.
  - 2. Apply slurry uniformly to all areas to be seeded in a 1-step process. Apply mulch at the minimum rate of 1500 lb per acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

### 3.6 SODDING NEW LAWNS

- A. Lay sod within 24 hours of stripping. Do not lay sod if dormant or if ground is frozen.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod across angle of slopes exceeding 1:3.
  - 2. Delete subparagraph below when not required. Steel staple anchors are commonly used. Add to subparagraph below when acceptable.
  - 3. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within 2 hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below the sod.

### 3.7 RECONDITIONING LAWNS

- A. Recondition existing lawn areas damaged by Contractor's operations, including storage of materials or equipment and movement of vehicles. Also recondition lawn areas where settlement or washouts occur or where minor regrading is required.
  - 1. Recondition other existing lawn areas.
- B. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.
- C. Where substantial lawn remains, mow, dethatch, core aerate, and rake. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- D. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of it off the Owner's property.
- E. Till stripped, bare, and compacted areas thoroughly to a depth of 6 inches.
- F. Apply required soil amendments and initial fertilizers and mix thoroughly into top 4 inches of soil. Provide new planting soil as required to fill low spots and meet new finish grades.

- G. Apply seed and protect with straw mulch as required for new lawns.
- H. Retain paragraph above or below.
- I. Apply sod as required for new lawns.
- J. Water newly planted areas and keep moist until new grass is established.

### 3.8 SATISFACTORY LAWN

- A. Seeded lawns will be satisfactory provided requirements, including maintenance, have been met and a healthy, uniform, close stand of grass is established, free of weeds, bare spots exceeding 5 by 5 inches, and surface irregularities.
- B. Sodded lawns will be satisfactory provided requirements, including maintenance, have been met and healthy, well-rooted, even-colored, viable lawn is established, free of weeds, open joints, bare areas, and surface irregularities.
- C. Replant lawns that do not meet requirements and continue maintenance until lawns are satisfactory.

### 3.9 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto surface of roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period until lawn is established.

### 3.10 PLANTING SOIL AMENDMENTS SCHEDULE

- A. Lawns: Provide soil amendments as required to ensure that the requirements as noted herein are met. The contractor shall test and adjust soil as required.

### 3.11 SEED MIXTURES SCHEDULE

- A. Full-Sun Mixture: Provide certified grass-seed blends or mixes, proportioned by weight, as follows:

Proportion	Name	Min. Pct. Germ.	Pct. Min. Pct. Pure Sd.	Max. Pct. Weed Sd.
100 pct.	Bermudagrass	80	85	0.50

Proportion	Name	Min. Pct. Germ.	Min. Pct. Pure Sd.	Max. Pct. Weed Sd.
	(Cynodon dactylon)			

- B. Sun and Partial Shade: Provide certified grass-seed blends or mixes, proportioned by weight, as follows:

Proportion	Name	Min. Pct. Germ.	Min. Pct. Pure Sd.	Max. Pct. Weed Sd.
50 pct.	Kentucky bluegrass	80	85	0.50
	(Poa pratensis)			
30 pct.	Chewings red fescue	85	98	0.50
	(Festuca rubra variety)			
10 pct.	Perennial rye grass	90	98	.50
	(Lolium perenne)			
10 pct.	Redtop	85	92	1.00
	(Agrostis alba)			

- C. Heavy Shade: Provide certified grass-seed blends or mixes, proportioned by weight, as follows:

Proportion	Name	Min. Pct. Germ.	Min. Pct. Pure Sd.	Max. Pct. Weed Sd.
50 pct.	Chewings red fescue	85	98	0.50
	(Festuca rubra variety)			
35 pct.	Rough bluegrass	80	85	1.00
	(Poa trivialis)			
10 pct.	Redtop	85	92	1.00
	(Agrostis alba)			

END OF SECTION





**SECTION 32 9500****TREES, SHRUBS, AND GROUNDCOVERS****PART 1 – GENERAL****1.1 DESCRIPTION OF WORK**

- A. Description of work: Work of this section includes, but is not limited to, the following:
1. Trees, shrubs, and groundcovers.
  2. Backfill mixtures.
  3. Mulching and planting accessories.
  4. Warranty and maintenance.

**1.2 RELATED WORK**

- A. Coordinate with the earthwork and appropriate site specifications for proper scheduling for the performance of the work specified herein.
1. Section 31 22 00: Earthmoving
  2. Section 32 90 00: Tree Conservation
  3. Section 32 93 05: Lawns and Grasses

**1.3 QUALITY ASSURANCE**

- A. Installer shall have not less than 5 years documented successful experience in installation of work similar to work of this Project and be a member of one of the following organizations:
1. Landscape Contractors Association.
  2. American Nursery and Landscape Association.
  3. Maryland Nurserymen's Association.

**1.4 SUBMITTALS**

- A. Product Data:
1. Submit manufacturer's data and source data for materials including soils.
  2. Submit location of product manufacture and harvest of primary raw materials.
- B. Schedules:
1. Submit schedule listing plants to be provided.
- C. Samples:

1. Submit to the Landscape Architect for review, one-pound (1lb.) samples packaged in plastic bags of mulch, topsoil, and soil mixes for all planting areas.
2. Provide samples typical of material used in Project with same color texture, and organic composition.

D. Test Reports:

1. Submit soil analysis of both soil mixes and topsoil, stating pH, nutrient levels (N.P.K), % organic matter, and mechanical analysis prepared by qualified soil testing lab along with samples. Test and Reports shall be paid for by the Contractor.

E. Qualification Data:

1. Submit installer qualifications verifying years of experience; include list of completed projects having similar scope of work identified by name, location, date, reference names and phone numbers.

F. Warranty and Maintenance:

1. Submit written warranty and maintenance agreement for materials as specified.

#### 1.5 WARRANTY AND MAINTENANCE AGREEMENT

- A. All plants shall be guaranteed to remain alive and healthy for two (2) full years after initial acceptance.

B. Inspection and Initial Acceptance:

1. Initial acceptance shall be defined as approval, by the Landscape Architect, of the complete landscape installation immediately after planting.
2. Contractor shall notify Landscape Architect, in writing, of project completion and request an inspection within two weeks.
3. If the plant material and workmanship are satisfactory, the Landscape Architect will give written notice to that effect. This will constitute the Certificate of Acceptance, and the warranty period will begin from that date.
4. Care of the plant material shall begin immediately after each plant item is satisfactorily installed and shall continue through the entire life of the contract. During this time, the Contractor shall do all work which is necessary to establish and keep the plants alive and healthy.

#### 1.6 FINAL INSPECTION:

- A. The Contractor will conduct a final Inspection with the Landscape Architect at the end of the two-year period. It will be the Contractors responsibility to notify the Landscape Architect within two weeks of the anticipated meeting.
- B. Any material that is 25% dead or more shall be considered dead and must be replaced at no charge. A tree shall be considered dead when the main leader has died back<sub>4</sub> or there is 25% of the crown dead.
- C. Deciduous material will be guaranteed to break dormancy if planted in dormant season.

#### 1.7 REPLACEMENTS AND CONDITIONS:

- A. Replacements will be made during the next appropriate planting period.
- B. The Contractor shall be responsible for a one-time replacement.
- C. Replacements will be of the same size and species as the original with no additional soil amendments to be used.
- D. The Contractor will not be responsible for plant material that has been damaged due to vandalism, fire, relocation or other activities beyond the contractor's control.
- E. Plant losses due to abnormal weather conditions such as floods, excessive wind, or severe freezing will not be the responsibility of the contractor.

### PART 2 - PRODUCTS

#### 2.1 TREES, SHRUBS AND GROUNDCOVERS

- A. General: Provide products grown and harvested within 500 miles of project site.
- B. Topsoil: New topsoil shall be good friable, natural loam topsoil, containing no subsoil material, free of sticks, stones, roots, weeds, debris or other extraneous matter, and shall be obtained from an area that has never been stripped and shall have an acidity range of pH 5.0 to pH 7.0.
- C. Soil Mix: Soil mix shall be 50% topsoil, 25% sand and 25% leaf mulch organic matter.
- D. Fertilizer: Fertilizer for planting areas and tree pits shall be approximately 5-10-5, and organically derived.
- E. Mulch: Mulch for groundcover areas shall be dark brown, shredded hardwood bark, or approved equal.
- F. Stakes (if needed): Stakes shall be 2" x 2" x 8' wood timbers.
- G. Guy Wires and Turnbuckles (if needed); Guy wire shall be No. 14 gage galvanized steel wire: turnbuckles shall be galvanized, 1/2' dia. bolt size with closed eyes to receive guy wires.

H. Rubber Hose (if needed): Rubber hose shall be  $\frac{3}{4}$ " black corded hose.

I. Plant Material

1. Plant List The Contractor shall be responsible for furnishing and installing all plant material shown on the drawings. The plant list is provided for convenience only. The plant quantities indicated on the plans take precedence over plant lists. Contractor shall verify all quantities to his own satisfaction prior to bidding. Any discrepancies shall be reported to the Landscape Architect immediately.
2. Nomenclature: The names of plants required under this contract conform to those given in Hortus III, 1979 Edition.
3. The Contractor shall have investigated the sources of supply and satisfied himself that he can supply all of the plants specified on the plant list in the size, variety and quality noted prior to submitting his bid. Failure to take this precaution will not relieve the successful bidder from his responsibility for furnishing and Installing all the plant material in strict accordance with the contract requirements and without additional expense to the owner. Substitutions will not be permitted. If proof is submitted that any plant specified is not obtainable, a proposal will be considered for use of nearest equivalent size or variety with an equitable adjustment of contract price. Such proof shall be substantiated and submitted in writing to the Landscape Architect.
4. All plants shall comply with the recommendations and requirements of ANSI Z60.1-1996 "American Standard for Nursery Stock".
5. Rejection: Any materials and/or work may be rejected if in the opinion of the Landscape Architect such does not meet the requirements of the specifications. All rejected materials shall be removed from the site by the Contractor within 45 hours.
6. Size: All trees and shrubs shall be measured when their branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch or root tip to tip. The determining measurement for trees shall be caliper, which shall be taken six (6") inches above the ground for trees up to four (4") inches in caliper and twelve (12") inches above the ground for larger sizes. All plants shall conform to the measurements specified in the plant lists except that plants larger than specified may be used if approved by the Landscape Architect. Use of such plants shall not increase the contract price. If larger plants are approved, the size of the root ball shall be increased in proportion to the size of the plant.
7. All "matched" species shall be from the same nursery source and nursery lot location.

## PART 3 – EXECUTION

### 3.1 EXAMINATION OF SITES:

- A. The Contractor shall examine the site and all conditions thereon, and take into consideration all such conditions that may affect his work. Start of work indicates acceptance of conditions and full responsibility for work of this section.

3.2 PERSONNEL:

- A. The work shall be performed by personnel familiar with the planting procedures under the supervision of qualified foremen.

3.3 PLANT INSPECTION:

- A. All plants shall be subject to inspection by the Landscape Architect for species, size, color, and quality. If so desired, a sample for each plant variety (tree, shrub, groundcover) shall be planted as specified. Once approved, these samples shall be tagged by the Contractor and used as standards of comparison for the remainder of the Work. Plant inspection shall be arranged by the Contractor at least one week prior to planting.
- B. Photographs of any material that is coming from suppliers outside the immediate project area may be submitted as typical samples for pre-approval.

3.4 PROTECTION AND REPAIR:

- A. All portions of the property, which have been disturbed or damaged due to, or incidental to, work performed under this contract shall be repaired and restored to its original condition to the satisfaction of the Landscape Architect.
- B. The Contractor shall fully and satisfactorily maintain and protect all work until completion and acceptance of all work or portions thereof and shall repair or replace, at his expense, any work damaged during that period, to the satisfaction of the Landscape Architect.

3.5 CLEANUP:

- A. At all times during the progress of the work, the contractor shall maintain the site in an orderly condition. Streets and pavements shall be kept clean. Materials and equipment for planting work shall be limited to the quantity required for the work. All rejected materials shall be immediately removed from the site.

3.6 TIMING:

- A. Planting work shall not be started until final grades have been established and approved by the Landscape Architect.
- B. Under no conditions shall any work be done if weather or soil conditions are not satisfactory.
- C. The season for planting trees, shrubs and groundcover shall be March 15 to June 1 and September 15 to November 15, unless otherwise approved by the

Landscape Architect. Any out of season planting will be fully guaranteed by the Contractor.

### 3.7 DIGGING AND HANDLING PLANT MATERIAL

- A. No plants shall be dug or delivered to the site until the required inspections have been made and the plants approved.
- B. Balled and burlapped (B&B) plants shall be dug with firm, natural balls of earth, of diameter and sufficient depth to include the fibrous and feeding roots. No plants will be accepted if the ball is cracked or broken before or during planting operations.
- C. Roots or balls of all plants shall be adequately protected at all times from sun and/or drying winds. Balled and burlapped plants that cannot be planted immediately upon delivery or collection from the site shall be set on the ground and protected with soil, wet peat or other acceptable material. Plants collected on site and planted immediately after digging need not be burlapped.
- D. No plant shall be bound with wire or rope at any time so as to damage the bark or break branches.
- E. Plants shall be pruned only as directed by the Landscape Architect.

### 3.8 PLANTING BEDS:

- A. Tree locations shall be staked by the Contractor and approved by the Landscape Architect before planting; all planting areas shall be excavated to depths and dimensions indicated; all subsoil shall be removed from the site.
- B. The sides and bottom of all planting beds shall be scarified.
- C. Planting beds shall be backfilled with specified soil mix and hand compacted.
- D. Fertilizer shall be mixed thoroughly into the full depth of all planting areas.

### 3.9 PLANTING:

- A. Setting Plants:
  - 1. Unless otherwise specified, all plants shall be planted in pits, centered and set on undisturbed soil to such depth that 1/8 of the rootball is above grade. Plants shall be planted upright and faced to give the best appearance or relationship to adjacent structures.
  - 2. No burlap shall be pulled out from under balls. Platforms, wire and surplus binding from top and sides of the ball shall be removed. All broken or frayed roots shall be cut off cleanly.
  - 3. When trees are delivered in wire baskets, the wire baskets shall be cut down the side of each mesh and peeled away from the rootball and removed in entirety.

4. Topsoil shall be placed and compacted carefully to avoid injury to roots and to fill all voids. When the hole is nearly filled, water shall be added as necessary and allowed to soak in. The hole shall be filled to finished grade and a shallow saucer shall be formed around each plant by placing a ridge of soil around the edge of each pit. After the ground settles, additional soil shall be filled into the pit to reach the level of the finished grade.
  5. After all backfill has been placed, water thoroughly on the interior of the tree saucer until it is filled, even if it is raining.
- B. Plant Locations: Plants shall be located as shown on the contract drawings, from dimensions if shown, and by scaling if not dimensioned. All locations are to be approved by the Landscape Architect before any excavation is started.
- C. Obstructions: All utilities shall be located in the field before any digging is begun. Any disruption or damage to utility lines shall be the responsibility of the Contractor.
- D. Pruning: Only dead and broken branches shall be removed from trees unless otherwise directed by the Landscape Architect. Plant material shall be pruned in accordance with standard horticultural practice to preserve the natural character of the plant. Only clean sharp tools shall be used.
- E. Mulching: All ground plant areas shall be mulched with a 2-inch layer of shredded hardwood bark within the entire area of the planting bed. Mulch shall be placed within 48 hours of planting.
- F. Clean-Up: No debris shall be left on-site. Excavated materials shall be removed or disposed of per Landscape Architect's instructions.

### 3.10 MAINTENANCE OF PLANT MATERIALS:

A. DESCRIPTION:

1. Maintenance shall begin immediately after each plant is installed. The landscape contractor shall provide all materials, labor and equipment to complete all landscape maintenance work for the two-year warranty period.

B. STANDARDS:

1. All landscape maintenance services shall be performed by trained personnel using current, acceptable horticultural practices.
2. All work shall be performed in a manner, which maintains the original intent of the landscape design.
3. All chemical applications shall be performed in accordance with current county, state and federal laws, utilizing EPA-approved

materials and methods of application. These applications shall be performed under the supervision of a Licensed Certified applicator.

C. WORKMANSHIP:

1. During landscape maintenance operations, all areas shall be kept neat and clean. Precautions shall be taken to avoid damage to existing structures. All work shall be performed in a safe manner to the operators, the occupants and pedestrians.
2. Upon completion of maintenance operations, all debris and waste materials shall be cleaned up and removed from the site, unless provisions have been granted by the owner to utilize on-site trash receptacles.
3. Any damage to the site caused by the Landscape Contractor shall be repaired by the Landscape Contractor without charge to the owner.

D. TREES, SHRUBS & GROUNDCOVERS:

1. Pruning: All ornamental trees, shrubs and groundcover shall be pruned when appropriate to remove dead or damaged branches, develop the natural form of the plant and create the effect intended by the Landscape Architect.
2. Weeding: All beds shall be weeded on a continuous basis throughout the growing season to maintain a neat appearance at all times.
3. Insect and Disease Control: The Landscape Contractor shall be responsible for monitoring the site conditions on each visit to determine if any insect or disease problems exist. Immediate measures shall be taken to eliminate any disease or infestation problems.
4. Trash Removal: The Landscape Contractor shall remove trash from all groundcover beds with each visit.
5. Winter Clean Up: Project shall receive a general clean up once during each of the winter months (January, February, March) to include: Removing all trash and unwanted debris, turning mulch where necessary, and inspection of grounds.
6. Watering: The Landscape Contractor shall be responsible for watering all plant material as necessary throughout the growing season.
7. Fertilizing: A slow release fertilizer of 5-10-5 shall be applied to all plant material at the end of the 1 yr. maintenance period.
8. Miscellaneous:
  - a. Mulch areas of all planting beds and tree pits shall be maintained at a 2" level.
  - b. Plants shall be reset to proper grade or upright position as necessary. Stakes and guys shall also be adjusted as necessary.



- c. The Contractor shall prepare maintenance guidelines for use by the Owner.
- d. All stakes and guys shall be removed by the Contractor at the end of two-year.
- e. Cut back tops of perennials. Dead tops of all perennials shall be cut back in February and the tops removed. Care shall be taken not to damage plants.

3.11 ACCEPTANCE:

- A. Final acceptance of the work by the Owner will be contingent on Contractor's compliance, with warranty and replacement requirements and Landscape Architect's approval. The Landscape Architect will notify the Owner within one week of final inspection.

**END OF SECTION**



**SECTION 33 1000****UTILITY STANDARDS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials, work and standards for site and utility construction materials and work.

**1.3 RELATED WORK**

- A. Refer to Section 31 20 00 "Earthmoving"; Section 33 41 00 "Storm Drainage", Division 22 "Plumbing" and Division 26 "Electrical".

**1.4 STANDARDS**

- A. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications".
- B. Maryland Department of Transportation State Highway Administration current "Standard Specifications for Construction and Materials", Measurement and Payment Clauses do not apply.
- C. American Concrete Institute (ACI).

**1.5 SUBMITTALS**

- A. Products:
  - 1. Submit typewritten list of selected products, when options are specified, within ten (10) calendar days after contract execution. Submit detailed shop drawings of utility modifications required by selection of options.
  - 2. Submit manufacturer's descriptive literature of structure castings.
  - 3. Submit Portland cement concrete mix design formula for each class specified.
  - 4. Submit certificates, signed by manufacturer or producer and contractor, stating the following comply with this specification:
    - a. Portland cement.
    - b. Fine aggregates.

- c. Coarse aggregates.
    - d. Portland cement concrete.
    - e. Concrete masonry units.
    - f. Brick.
    - g. Foundation materials.
    - h. Bedding materials.
  - 5. Submit shop drawings, of the following, indicating concrete reinforcement locations, size and placement:
    - a. Cast in place reinforced concrete structures.
    - b. Pre-cast reinforced concrete structures.
  - 6. Submit location of product manufacture and of extraction/recovery of primary raw materials.
  - 7. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.
  - 8. Submit certification of FSC-certified sustainably harvested wood formwork materials, if applicable.
- B. Compaction Equipment: Submit compaction equipment data prior to start of controlled fill earthwork operations.
- C. Testing: Submit test reports of testing specified.
- D. "As-Built" Plans: Submit "as-built" plans for water, sanitary sewer and storm drainage systems. Submit to the Owner's Representative and to controlling utility agencies as required.
- 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING
- A. Delivery: Schedule delivery operations to avoid unnecessary re-handling.
- B. Storage:
- 1. General: Store in accordance with manufacturer's recommendations and as noted.
  - 2. Portland cement: Store on platforms above ground and protect from adverse environmental conditions.
  - 3. Aggregates: Store to prevent foreign material contamination.
  - 4. Utility Joint Materials and Lubricants: Store in cool and dry location free of oil, grease, excessive heat and direct sunrays.
- C. Handling:
- 1. General: Comply with manufacturer's recommendations and as noted.
  - 2. Aggregates: Handle to prevent segregation.
  - 3. Pre-cast Concrete Structures: Handle to prevent damage. Utilize lifting holes provided by structure manufacturer.

## 1.7 DEFINITIONS

- A. Refer to Section 31 20 00 "Earthmoving".

## 1.8 PROJECT CONDITIONS

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Traffic: Maintain pedestrian and vehicular traffic during utility construction operations.
- C. Limitations:
  - 1. Environmental: Do not place Portland cement products or erect masonry when ambient air temperature is below 40 degrees Fahrenheit or air temperature has been below 35 degrees Fahrenheit for twelve or more consecutive hours or between 15 November and 1 March without written authorization from the Owner's Representative or the Architect.
- D. Certifications, Inspections and As-Built Documents:
  - 1. The Contractor shall provide inspection, certification and "as-built" plans of the on-site water, sanitary sewer service and storm sewer work by a registered professional Engineer. Contractor shall notify the Architect within 15 calendar days of signing the contract who the Maryland Registered P.E. will be and who will certify the as-built water and sewer plan. Show any changes and include ties for the location of valves, bends, manholes, fire hydrants, and laterals accompanied by the qualifying air test date and certification of compliance. See Division One "Project Record Documents" for format of "as-built" drawings.
  - 2. All storm drain system work must be inspected by Prince George's County in accordance with agency permit requirements. Record of as-built conditions will be required.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the project site.
- B. Portland Cement Concrete: SHA Section 902, Portland Cement Concrete and Related Products.
  - 1. Water: Clean and free of oil, acid and injurious amounts of vegetable matter, alkalis and salts. River, stream or lake water is prohibited.
  - 2. Forms: Wood, steel or as specified. Form materials to produce smooth

surfaces, free of irregularities. Nonrented wood formwork shall be made of FSC-certified sustainably harvested wood materials.

C. Mixes:

1. Class "A" Concrete: SHA Mix No. 4, Table 902 A. 28-Day compressive strength 3500 P.S.I. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05.
2. Class "B" Concrete: SHA Mix No. 2, Table 902 A. 28-Day compressive strength 3000 P.S.I. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05.

E. Concrete Reinforcements:

1. Steel bars: ASTM A 615, Grade 60, deformed, designation as indicated or specified. Minimum 99% recycled-content, of which minimum 60% shall be post-consumer and the remainder may be post-industrial material.
2. Steel Wire Mesh: ASTM A 185 welded wire mesh, roll type, size as indicated or specified.

F. Brick:

1. Type A: ASTM C 55 Concrete Building Brick, type I, grade N, standard manufacture size.
2. Type B: ASTM C 32 Clay or Shale Brick, grade SS or as specified, solid, 2-1/4 by 3-3/4 by 8 inches.

G. Cement Mortar: SHA Section 902.05, Masonry Cement.

1. Water: As specified for Portland cement concrete.

H. Cast-in-Place Reinforced Concrete Structures:

1. Structure Bases: Class "B" Portland Cement Concrete.
2. Structure Walls and Top Slabs: Class "A" Portland Cement Concrete.
1. Concrete Reinforcement, Structural Steel, Structure Castings and Appurtenances: As indicated and specified.

I. Pre-Cast Reinforced Concrete Structures:

1. Square and Rectangular Structures: ASTM C 858.
2. Structural Design Loading: ASTM C 858, live load designation A-16.
3. Circular Structures: ASTM C 478.
1. Structure Joints: ASTM C 443.

J. Foundation Materials:

1. Type I: ASTM C 33 Coarse Aggregate, size No. 8 (3/8 inch to No. 8).
2. Type II: SHA Coarse Aggregate Size No. 57 stone (1 1/2 inch to No. 8).
3. Type III: Earth material free of debris, waste materials, frozen materials, vegetable matter, clay, rocks or stones exceeding 1 inch in any dimension. Obtain Type III material from on-site excavations or off-site borrow areas approved by the Soils Engineer.

K. Bedding Materials:

1. Type A: ASTM C 33 Fine Aggregate.
2. Type B: ASTM C 33 Coarse Aggregate, size No. 6 (1 inch to No. 4).
  - a. Contractor's Option: SHA Coarse Aggregate Size No. 57 stone (1 1/2 to # 8.)
  - b. Recycled concrete RC-6 may, at Contractor's discretion, be used for bedding in approved locations.
3. Type C: Earth material free of debris, waste materials, frozen materials, vegetable matter, clay and rocks or stones exceeding one inch in any direction.

L. Bedding Material Schedule:

1. Storm drainage system: Type B, or as per manufacturers recommendations.
2. Water Distribution System: W.S.S.C. Standards, or Type A.
3. Sanitary Sewer System: W.S.S.C. Standards, or Type B.
4. All other utilities: Type C.

M. Backfill Materials: As specified for Fill or Backfill, Section 31 20 00 "Earthmoving", and as noted.

1. Utility Trenches:
  - a. Phase I: Earth material free of debris, waste materials, frozen materials, vegetable matter and rock or stones exceeding one inch in any dimension.
  - a. Phase II: Earth material free of debris, waste material, frozen material, vegetable matter and rock or stones exceeding two inches in any dimension.
2. Utility Structures: Earth material free of debris, waste material, frozen material, vegetable matter and rock or stones exceeding two inches in any dimension. Obtain backfill material from the following: Excavated material approved by the Soils Engineer or the Owner's Representative.

## PART 3 - EXECUTION

### 3.1 PROTECTION AND RESTORATION

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.

- B. General: Provide support systems (e.g. sheeting, shoring, sheet piling, cribbing, etc.) at no increase to contract sum. Cut off timber when using timber support systems above top of utility to prevent utility displacement. Exercise care when using trench shields or boxes during shield movement to prevent utility displacement.

### 3.2 EXISTING UTILITIES

- A. Refer to Section 31 20 00 "Earthmoving", and as noted. Contractor shall notify "Miss Utility" at least 48 hours prior to start of construction.
- B. Provide test pits at all existing utility crossings prior to any system construction. Verify utility inverts for review by Architect or the Owner's Representative to determine potential conflicts prior to start of system construction.

### 3.3 DEWATERING

- A. Refer to Section 31 20 00 "Earthmoving".

### 3.4 EXCAVATION

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Trench Excavation: Open cut method or as specified. Excavate materials encountered to subgrade elevations indicated or specified.
  - 1. Trench width below top of utility not to exceed the following clearances on each side of utility:
  - 2. 

Utility Exterior Width,	<u>Clearance</u>
<u>Diameter or Span</u>	
1 thru 30 in.	16 in.
31 and higher	24 in.
  - 2. Excavate utility trenches to the following depths:
    - a. Circular storm drainage pipe: Six inches below bottom of pipe.
    - b. Water distribution pipe: W.S.S.C. Standards or four inches below bottom of pipe.
    - c. Sanitary sewer pipe: W.S.S.C. Standards or six inches below bottom of pipe.
    - d. All other utilities: Bottom of utility.
- C. Structure Excavation:
  - 1. Utility structure excavation to produce 12-inch clearance between exterior structure walls and excavation walls or support systems.
  - 2. Extend excavation to the following:
    - a. Cast in place reinforced concrete structures: Six inches beyond



structure base.

- b. Pre-cast reinforced concrete structures: Six inches below bottom of pre-cast structure base.
- c. Pre-cast reinforced concrete structure with cast in place concrete base: Bottom of structure base.
- d. Masonry structures: Bottom of structure base.

### 3.5 OVER-EXCAVATION

- A. Refer to Section 31 20 00 "Earthmoving", except as noted.
- B. Utility Trenches:
  - 1. Correct over-excavation of water distribution, storm drainage and gravity flow sanitary sewer systems by backfilling over-excavated trenches with Type II foundation (Type B bedding) material and compacting.
  - 2. Correct over-excavation of all other utilities by backfilling over-excavated trenches with Type III foundation (Type C bedding) material and compacting.
  - 3. Place material in loose lifts not exceeding eight inches. Compact each lift to 98 percent maximum dry density. Density test method: ASTM D 698.
- C. Structures: Correct utility structure over-excavation by backfilling over-excavation with Type II foundation (Type B bedding) material and compacting.
  - 1. Place material in loose lifts not exceeding eight inches. Compact each lift to 98 percent maximum dry density. Density test method: ASTM D 698.

### 3.6 UNSUITABLE EARTH

- A. Refer to Section 31 20 00 "Earthmoving", except as noted.
- B. Restore unsuitable earth excavation as specified for over-excavation.

### 3.7 EXCAVATED MATERIAL STORAGE

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Stockpile select excavated materials required for backfill operations.

### 3.8 PORTLAND CEMENT CONCRETE CONSTRUCTION

- A. Mixing:
  - 1. Ready-Mixed Concrete: ASTM C 94.
  - 2. Project Site Batch Mixing: ACI 301, Chapter 7.

- B. Formwork: ACI 301, Chapter 4.
- C. Reinforcement: ACI 301, Chapter 5.
- D. Joints and Embedded Items: ACI 301, Chapter 6.
- E. Placement: ACI 301, Chapter 8.
- F. Surface Defects: ACI 301, Chapter 9.
- G. Finishes: ACI 301. Non-Exposed: Section 10.2.1. Exposed: Section 10.2.2.
- H. Curing and Protection: ACI 301, Chapter 12.
- I. Cold Weather Concreting: ACI 306R.
- J. Hot Weather Concreting: ACI 305R.

### 3.9 STRUCTURES

- A. Cast in Place Reinforced Concrete Structures: Construct cast in place concrete structures as indicated and specified.
- B. Pre-cast Reinforced Concrete Structures:
  - 1. Pre-cast structure base: Place Type I foundation material, on excavation subgrade, to bottom of structure base and compact to 98 percent of maximum dry density by ASTM D 698. Install pre-cast structure base, on compacted foundation material, level to 1/8 inch in 5 feet. Clean and lubricate structure joints, immediately prior to installation, in accordance with manufacturer's recommendation. Install pre-cast reinforced structure sections, on structure base, plumb to 1/4 inch in 10 feet. Position structure sections on previously installed section and push joints tightly together. Position concrete top slabs on structure as indicated. Plug lifting holes with cement mortar. Install frames and covers to finished grade with bricks and cement mortar.
- C. Masonry Structures:
  - 1. Erect structure walls with masonry materials specified. Wet each masonry unit thoroughly before placement. Shove each unit into place in full bed of cement mortar. Horizontal and vertical joints not to exceed 1/2 inch.
  - 2. Bond and Coursing: Brick Masonry - Common Bond.
  - 3. Fill joints completely with cement mortar. Fit masonry units tightly around utilities projecting through structure walls. Space, set and bond structure appurtenances as indicated or specified during masonry erection. Point up interior structure joints and clean removing excess cement mortar. Parge

exterior structure walls with 1/2 inch thick cement mortar and finish with smooth trowel. Masonry construction tolerances not to exceed 1/4 inch in 10 feet vertical from plumb.

### 3.10 BEDDING

- A. Storm drainage pipe: Place bedding material, on excavated trench subgrade to bottom of pipe and compact. Upon completion of pipe installation, place and compact bedding material to springline of pipe.
- B. All Other Utilities: Bedding not required. Install utilities on excavated trench subgrade as indicated or specified.

### 3.11 BACKFILL

- A. Backfill utility trenches in two consecutive phases as follows:
  - 1. Phase I - Backfill to 12-inch depth above top of utility. Place backfill material in loose lifts not exceeding six inches. Compact each lift to 98 percent maximum dry density. Density test method: ASTM D 698.
  - 2. Phase II - Unpaved Areas: Place backfill material to grade in loose lifts not exceeding 24 inches. Compact each lift to 92 percent maximum dry density. Density test method: ASTM D 698
  - 3. Phase II - Paved Areas: Place backfill material to grade in loose lifts not exceeding eight inches. Compact each lift to 98 percent maximum dry density. Density test method: ASTM D 698.
- B. Backfill utility structures as follows: Place backfill material carefully and in loose lifts not exceeding 12 inches (paved areas - 8 inches) in depth. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698. Do not backfill masonry structures until cement mortar parge attains initial set.

### 3.12 EXCAVATED MATERIAL DISPOSAL

- A. Refer to Section 31 20 00 "Earthmoving".

### 3.13 WASTE MANAGEMENT:

- D. Recycle waste materials in accordance with Division 1 "Construction Waste Management" requirements.

**END OF SECTION**



**SECTION 33 1005****WATER DISTRIBUTION SYSTEM****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials and work required to construct water distribution system.

**1.3 RELATED WORK**

- A. Refer to Section 33 10 00 "Utility Standards".

**1.4 STANDARDS**

- A. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".
- B. Washington Suburban Sanitary Commission's current "Regulations Governing the Installation of Plumbing and Sewer Cleaning in the Washington Suburban Sanitary District".
- C. American Water Works Association (AWWA).

**1.5 SUBMITTALS**

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Products: Submit product manufacturer's specifications and installation instructions and certificates of compliance signed by manufacturer and contractor stating that products comply with this specification to the Architect. Certificates of compliance must be notarized, signed by an officer of the Manufacturer, and shall include W.S.S.C. Contract Number or On-site number, job location, Contractor's name, types, classes and strengths of pipe and fittings, and the Manufacturer's name.
- C. Submit As-built drawings to the Architect.
- D. Service Connection Permit: Contractor shall submit to Architect all items required

by WSSC to obtain a Service Connection Permit, including but not limited to: All required WSSC Bonds, Letter indicating Utility Contractor, and Certificate of Insurance. The Architect will obtain the Service Connection Permit once all these items are received.

#### 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.

#### 1.7 PROJECT CONDITIONS

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.
- B. Jurisdiction Standards: Site is located within WSSC jurisdiction. On-site fire hydrants shall be "Metered Fire Hydrants".
- C. All on-site construction and materials shall be in accordance with the latest edition of the W.S.S.C. General Conditions and Standard Specifications, Design Manual, Standard Details and Plumbing and Gasfitters Regulations.

#### 1.8 CONSTRUCTION SURVEYS

- A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 50 feet and at all appurtenances (e.g. fittings, valves, etc.). Provide construction cut sheet preparation as required.

#### 1.9 SPECIAL INSPECTIONS, TESTING OBSERVATION AND CERTIFICATIONS

- A. Special utility inspections, testing observation and certifications are those services specifically required by government agencies and/or utility purveyors, and that must be performed by the Engineer of Record.
- B. In accordance with the requirements and regulations of the Washington Suburban Sanitary Commission, the Owner has retained the services of the Engineer of Record to provide the following special inspection, testing observation and certification services in connection with the construction of WSSC On-Site water lines and appurtenances.
  - 1. Four (4) Three (3) hour inspection visits for on-site water line construction
  - 2. One (1) Four (4) hour visit to observe mandatory 2- hour pressure test
  - 3. Two (2) Three (3) hour inspection visits to observe construction of thrust blocking
  - 4. One (1) time preparation of As-Built Drawings and Certifications to be performed upon completion of construction and successful testing of all on WSSC On-Site Water and Sewer lines and appurtenances.
- C. ADDITIONAL INSPECTIONS, OBSERVATIONS AND CERTIFICATIONS: It shall be

the responsibility of the contractor to hire the Engineer-of-Record to perform any additional special inspections, testing observations and certifications required beyond those specific services identified herein as being provided by the Owner.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. All materials shall be W.S.S.C. Standards and shall meet all W.S.S.C. requirements indicated.
- B. Valve Boxes: Cast iron two-piece valve boxes, screw type box, bell base section, 5-1/4 inch shaft, round drop cover with "W" marking.

### 2.2 FIRE HYDRANTS

- A. WSSC Standard. Fire Hydrants shall be Supervised type hydrants. Provide all coordination, materials and equipment necessary for the supervision system.

### 2.3 CONCRETE PADS: Class 'A' Portland cement.

### 2.4 CONCRETE ANCHORS: W.S.S.C. Standards indicated and specified. Class 'A' Portland cement concrete, Section 33 10 00 "Utility Standards".

### 2.5 STRAPS AND RODS

- A. Clamps, Straps and Washers: Steel, ASTM A 506.
- B. Rods: Steel, ASTM A 575.
- C. Rod Couplings: Malleable-Iron, ASTM A 197
- D. Bolts: Steel, ASTM A 307
- E. Cast-Iron Washers: Gray-iron, ASTM A 126

### 2.6 MISCELLANEOUS PRODUCTS

- A. Underground Identification Tape: Manufactured by Allen Systems, Houston, Texas.
  - 1. Type: "Markline".
  - 2. Color: Precaution Blue.
  - 3. Legend: Caution water line buried below.
  - 4. Tape Width: Three inches.
- B. Disinfection Products: W.S.S.C. standards indicated and specified. For continuous feed disinfection method, use Calcium Hypochlorite: AWWA B 300, granular form.
  - 1. Contractor's Option: AWWA B 301 Liquid Chlorine.

2. Contractor's Option: AWWA B 303 Sodium Chloride.
3. Water: Potable.

### PART 3 - EXECUTION

#### 3.1 PROTECTION AND RESTORATION

- A. Refer to Section 33 10 00 "Utility Standards".

#### 3.2 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:

- A. Refer to Section 33 10 00 "Utility Standards".

#### 3.3 PIPE

##### A. General:

1. Install in accordance with pipe manufacturer's installation instructions, W.S.S.C. standards and requirements and as noted.
2. Inspect each pipe laying length, pipe joint materials and fittings for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Place fittings at changes in horizontal and vertical alignment as indicated. Construct concrete anchors at each fitting as indicated. Place concrete to permit access to joints for inspection and maintenance. Apply liberal coat of coal tar pitch to exposed steel and hardware. Field cut pipe only where required to complete closures or to install fittings, valves or fire protection equipment. Cut pipe to smooth square end with equipment designed for cutting pipe.

##### B. Ductile Iron Pipe:

1. Install pipe in accordance with AWWA C 600 and as noted.
2. Install with bell ends facing in direction of laying operations. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed upgrade. Place identifying mark on pipe not provided with spigot depth mark. Clean interior and exterior surfaces of bell and spigot removing oil, grit, excess coating and foreign matter. Lubricate pipe ends and gasket in accordance with pipe manufacturer's instruction.

- C. Ductile Iron Push-On Pipe: Position each laying length in previously installed pipe and push or pull joint tightly together with mechanical device designed for pipe jointing. Grind or file spigot end of field cut pipe to resemble manufactured spigot end. Place spigot identifying depth mark as specified. Pipe joint deflection not to exceed the limits specified in Table 2, AWWA C 655.

#### 3.4 BURIED VALVES

- A. Install valves in accordance with valve manufacturer's installation instructions, and



W.S.S.C. requirements.

### 3.5 FIRE HYDRANTS

- A. General: Install fire hydrants at locations indicated, in accordance with AWWA M17 "Installation, Operation and Maintenance of Fire Hydrants", manufacturer's installation instructions, and W.S.S.C. standards and requirements.
- B. All on-site fire hydrants installed within WSSC jurisdiction shall be "Supervised Fire Hydrants". Contractor shall be responsible for coordinating fire hydrant acquisition and installation with a WSSC approved monitoring company. Contractor shall also coordinate installation with mechanical and electrical contractors for required connections, panels or power supplies. All required monitoring equipment, connections, power supplies, testing and incidentals shall be provided, at no increase to the contract sum, for a completed and approved monitoring system.

### 3.6 BACKFILL

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Waterman's 4-inches and larger must be inspected by the Architect prior to completion of backfill operations. Contractor shall provide a minimum of 48 hours notice to the Architect before completion of backfill operations.
- C. Valve Box Installation: Install valve box for each buried gate valve during backfill operations. Install boxes to prevent shock or stress transmission to valves or pipe and center over valve operating nut plumb to 1/4 inch in five feet. Adjust box cover flush to finished grade.
- D. Underground Identification Tape: Install tape during backfill operations. Tape shall be centered over pipe, located 24 inches below finished grade.

### 3.7 SYSTEM TESTING

- A. General: Provide materials, equipment (e.g. pumps, gauges, etc.) and labor required to test system. Do not conduct tests until concrete anchors cure and set seven calendar days. Provide a minimum of 48 hours notification of planned testing. Test observation by the Architect and local governing water authority personnel. Test system in accordance with AWWA C 600 and as noted.
- B. Hydrostatic Pressure Tests: Conduct hydrostatic pressure tests, upon completion of Phase I backfill operations. Fill systems or valved section of system with water. Expel air from pipe. Slowly apply test pressure. Test pressure to be per approved plan. Test duration to be two hours. Test pressure shall not vary more than +5 psi for the duration of the test. Examine all system joints. Correct defective products or improper system installation as directed by the Architect and local governing water authority personnel.

- C. Hydrostatic Leakage Tests: Conduct hydrostatic leakage tests upon completion of Phase II backfill operations. Test procedure as specified for hydrostatic pressure tests, except as noted. Test duration 24 hours. Allowable leakage for ductile iron pipe is not to exceed the limits specified in Table 3, AWWA C 600. Correct system installation exceeding allowable leakage specified as directed by the Architect and local governing water authority personnel.

### 3.8 INSPECTION AND CERTIFICATION

- A. Retain the services of a Maryland-registered Professional engineer for inspection of system construction and certification that system complies with standards specified. In accordance with the requirements on the approved WSSC drawings, the inspecting engineer must be the engineer of record for the approved WSSC drawings.

### 3.9 SYSTEM DISINFECTION

- A. Disinfect system in accordance with AWWA C 651, W.S.S.C. standards specified, and as noted. Provide materials, equipment (e.g. pumps, etc.) and labor required to disinfect system.
- B. Disinfection Method: Continuous feed.
  - 1. Preliminary and final flushing velocity to be 2.5 fps. Solution concentration as specified. Maintain 50 MG/L available chlorine during 24-hour disinfection period. Bacteriologic test interval every six hours. Flushing and drainage locations where directed by the Owner's Representative.

### 3.10 DISINFECTION TESTING

- A. Conduct chlorine residual tests upon completion of final flushing operations. Repeat disinfection operation until satisfactory chlorine residual quality tests are obtained.

### 3.11 WATER BACTERIOLOGIC QUALITY TESTING

- A. Retain the services of an independent testing laboratory to conduct water bacteriologic quality testing.

**END OF SECTION**

**SECTION 33 3000****SANITARY SEWERAGE****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials and work required to construct gravity flow sanitary sewer system.

**1.3 RELATED WORK**

- A. Refer to Section 31 20 00 "Earthmoving", Section 33 10 00 "Utility Standards", Section 33 41 00 "Storm Drainage", and Division 26 "Plumbing".

**1.4 STANDARDS**

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.
- B. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".
- C. Washington Suburban Sanitary Commission's current "Regulations Governing the Installation of Plumbing and Sewer Cleaning in the Washington Suburban Sanitary District".

**1.5 SUBMITTALS**

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Products: Submit product manufacturer's specifications and installation instructions and certificates of compliance signed by manufacturer and contractor stating that products comply with this specification to the Architect. Certificates of compliance must be notarized, signed by an officer of the Manufacturer, and shall include W.S.S.C. Contract Number or On-site number, job location, Contractor's name, types, classes and strengths of pipe and fittings, and the Manufacturer's name.
- C. Options: Submit typewritten list of selected products when options are specified

within 10 calendar days after contract execution. Submit detailed shop drawings of system modifications required by selection of options.

- D. Submit shop drawings of precast structures indicating concrete reinforcement location, size and placement.
- E. Submit As-built drawings to the Architect.
- F. Service Connection Permit: Contractor shall submit to Architect all items required by WSSC to obtain a Service Connection Permit including but not limited to: All required WSSC Bonds, Letter indicating Utility Contractor, and Certificate of Insurance. The Architect will obtain the Service Connection Permit once all these items are received.

#### 1.6 PRODUCT, DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 33 10 00 "Utility Standards".

#### 1.7 PROJECT CONDITIONS

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. All on-site construction and materials shall be in accordance with the latest edition of the W.S.S.C. General Conditions and Standard Specifications, Design Manual, Standard Details and Plumbing and Gasfitters Regulations.
- C. Existing Sanitary Sewer System: Provide, install, operate and maintain pumps and related equipment required to divert sewage (bypass pumping) during system construction. Extend pump discharge lines to existing sanitary sewer structures. Surface flow is prohibited.
- D. Traffic: Maintain vehicular and pedestrian traffic during system construction.

#### 1.8 CONSTRUCTION SURVEYS

- A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 25 feet maximum and at all structures. Provide construction cut sheet preparation as required.

#### 1.9 SPECIAL INSPECTIONS, TESTING OBSERVATION AND CERTIFICATIONS

- A. Special utility inspections, testing observation and certifications are those services specifically required by government agencies and/or utility purveyors, and that must be performed by the Engineer of Record.

- B. In accordance with the requirements and regulations of the Washington Suburban Sanitary Commission, the Owner has retained the services of the Engineer of Record to provide the following special inspection, testing observation and certification services in connection with the construction of WSSC On-Site water lines and appurtenances.
1. Four (4) Three (3) hour inspection visits for on-site water line construction
  2. One (1) Four (4) hour visit to observe mandatory 2- hour pressure test
  3. Two (2) Three (3) hour inspection visits to observe construction of thrust blocking
  4. One (1) time preparation of As-Built Drawings and Certifications to be performed upon completion of construction and successful testing of all on WSSC On-Site Water and Sewer lines and appurtenances.
- C. ADDITIONAL INSPECTIONS, OBSERVATIONS AND CERTIFICATIONS: It shall be the responsibility of the contractor to hire the Engineer-of-Record to perform any additional special inspections, testing observations and certifications required beyond those specific services identified herein as being provided by the Owner.

## PART 2 - PRODUCTS

### 2.1 MATERIALS:

- A. All materials shall be W.S.S.C. Standards and shall meet all W.S.S.C. requirements indicated.
- B. Polyvinyl Chloride (PVC) Pipe: W.S.S.C. Standards indicated. ASTM D 3034, SDR 35 PVC gravity sewer pipe, size as indicated, standard manufacture laying length.
1. Pipe Joints: ASTM D 3212 bell and spigot type, with flexible elastomeric gasket seals. Gaskets shall meet the requirements of ASTM F 477.
  2. Fittings shall be as indicated and required.
- C. Cleanouts: W.S.S.C. standards indicated.
1. Cleanouts For Use in Paved Walk Areas: Refer to Section 33 41 00 "Storm Drainage", and as noted.
    - a. Expansion Joint: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.
  2. Furnish the Owner with one cleanout wrench.
- D. Structures: W.S.S.C. standards specified and indicated.
- E. Foundation and Bedding Materials: Refer to Section 33 10 00 "Utility Standards".

- F. Concrete: Refer to Section 33 10 00 "Utility Standards".
- G. Miscellaneous Products:
  - 1. Underground identification type manufactured by Allen Systems, Houston, Texas. "Detectatape" type, three inches wide, marked "Caution Sewer Line Buried Below", "Safety Green" color.

### **PART 3 - EXECUTION**

#### **3.1 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH**

- A. Refer to Section 33 10 00 "Utility Standards".

#### **3.2 EXISTING SYSTEM CONNECTION**

- A. Notify WSSC no less than 48 hours prior to the start of system construction.
- B. Excavate and expose existing pipe at connection location indicated. Adjust connection location, as required, in the event of conflicts with existing pipe joints. Neatly cut existing pipe and prepare cut end as required for connection with new pipe. Make connections with existing pipe using fittings designed for the purpose, in accordance with manufacturer's installation instructions.

#### **3.3 PIPE**

- A. General: Install in accordance with manufacturer's installation instructions and as noted. Inspect each pipe laying length and pipe joint materials for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Begin with installation at lowest system elevation and proceed up-grade. Field cut pipe only where required to complete structure-to-structure closures, install fittings or as specified. Cut pipe to smooth square end with equipment designed for cutting pipe.
- B. Polyvinyl Chloride (PVC) Pipe: Install pipe in accordance with ASTM D 2321, manufacturer's installation instructions, and as noted.
  - 1. Install with pipe spigot end pointing in flow direction. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed up-grade. Clean bell and spigot interior and exterior surfaces, removing oil, grit and foreign matter. Lubricate pipe ends and gasket in accordance with manufacturer's instructions. Position each laying length of previously installed pipe and manually push joint tightly together.
  - 2. Field Pipe Cutting: Shape spigot end of cut pipe to resemble manufactured spigot end, with a pipe-beveling tool designed for PVC pipe. Copy the full insertion mark provided on the manufactured spigot end onto the prepared

field cut end.

### 3.4 EXISTING PIPE/STRUCTURE CONSTRUCTION

- A. Excavate and expose existing pipe at structure location indicated. Adjust structure location as directed by the Architect or Owner's Representative in the event existing pipe joint interferes with structure walls, or as required to obtain required invert, at no increase to contract sum. Manually excavate below existing pipe prior to structure base placement. Place concrete structure base and construct structure as specified. Neatly cut and remove upper half of existing pipe and construct invert flow channel.

### 3.5 STRUCTURES

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Pipe Connections: Install pipe opening sleeves in accordance with manufacturer's installation instructions. Neatly cut pipes flush with interior structure walls except as otherwise indicated or specified.
- C. Structure Joints: Apply liberal coat of joint coating material to each structure section joint in accordance with manufacturer's application instructions.
- D. Invert Flow Channels: Construct invert flow channels smooth and semicircular in shape. Shape channels with horizontal circular curve radii as large as structure will permit. Neatly form channels in structure base with bricks and cement mortar.

### 3.6 CLEANOUTS

- A. Refer to Section 33 41 00 "Storm Drainage", and as noted.
- B. Install cleanouts in accordance with manufacturer's installation instructions and as indicated.
  - 1. Construct concrete pads of Class "A" concrete as indicated.
  - 2. Cleanouts in paved walk shall be installed without a concrete pad. Top shall be cast into and set flush with finished walk surface.

### 3.7 BACKFILL

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.
- B. Sanitary Sewer mains must be inspected by the Architect prior to completion of backfill operations. Contractor shall provide a minimum of 48 hours notice to the Architect before completion of backfill operations.
- C. Underground Identification Tape: Install tape during backfill operations. Tape shall

be centered over pipe, located 12 inches above top of pipe.

### 3.8 SYSTEM TESTING

- A. Provide equipment, materials and labor required to test system. Conduct low pressure air tests in accordance with local jurisdiction approving agency standards. Provide a minimum of 48 hours notification of planned testing. Test observation by the Architect and W.S.S.C. personnel.
- B. Repair or replace defective products and system construction, which fails tests as directed by local jurisdiction approving agency. Provide additional corrective work and retesting until system is approved and accepted. Provide corrective work and retesting at no increase to contract sum.

### 3.9 SYSTEM INSPECTION

- A. Retain the services of a Maryland-registered engineer for inspection of system construction and certification that system complies with standards specified. In accordance with the requirements on the approved WSSC drawings, the inspecting engineer must be the engineer of record for the approved WSSC drawings.
- B. Provide additional corrective work, determined necessary by television inspection, as specified for system testing.

**END OF SECTION**



**SECTION 33 4100****STORM DRAINAGE****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, Specifications Section, apply to work in this section.

**1.2 DESCRIPTION OF WORK**

- A. This section specifies materials and work required to construct storm drainage system.

**1.3 RELATED WORK**

- A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving", Section 33 10 00 "Utility Standards"; Section 32 13 13 "Cement Concrete Paving" and Division 22 "Plumbing".

**1.4 STANDARDS**

- A. Washington Suburban Sanitary Commission (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".
- B. Prince George's County Department of Transportation current "Design Standards".
- C. Maryland Department of Transportation State Highway Administration current "Standard Specifications for Construction and Materials".
- D. Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition.
- E. American Concrete Pipe Association (ACPA).
- F. Cast Iron Soil Pipe Institute (CISPI).

**1.5 SUBMITTALS**

- A. Products:
  - 1. Submit certificate signed by manufacturer and contractor stating that pipe and pipe joint materials comply with this specification.
  - 2. Submit shop drawings of pre-cast reinforced structures and cast in place reinforced concrete structures indicating location, size and placement of

concrete reinforcement.

3. Submit manufacturer's descriptive literature of cleanouts.
4. Submit location of product manufacture.

1.6 PROJECT CONDITIONS:

- A. Refer to Section 31 20 00 "Earthmoving" and as noted.
- B. Existing Storm Drainage System: Provide, install, operate and maintain pumps and related equipment required to divert storm water during system construction.
- C. Traffic: Maintain pedestrian and vehicular traffic during system construction.

- D. As-Built Documents:
  - 1. Refer to Section 33 10 00 "Utility Standards"

#### 1.7 CONSTRUCTION SURVEYS:

- A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 25 feet maximum and at all structures. Provide construction cut sheet preparation as required.

### PART 2 - PRODUCTS:

#### 2.1 MATERIALS:

- A. General: Provide products manufactured within a 500-mile radius of the Project Site
- B. Polyvinyl Chloride (PVC) Pipe: ASTM D 3034, Schedule 40 PVC gravity sewer pipe, size as indicated, standard manufacture laying length.
  - 1. Pipe Joints: ASTM D 3212, bell and spigot type, with flexible elastomeric gasket seals. Gaskets shall meet the requirements of ASTM F 477.
  - 2. Fittings shall be as indicated and required.
- C. Concrete Pipe: ASTM C 76, Class IV, standard manufacture laying length.
  - 1. Pipe Joints: Rubber gaskets, ASTM C 443 with vegetable oil soap joint lubricant.
  - 2. Mortar Joints: Modified tongue and groove pipe with cement mortar.
- D. High Density Polyethylene Pipe: ADS Type N-12, or approved equal.
  - 1. Pipe Joints: All joints must meet a modified ASTM 3212 at 3.5-psi held for 10 minutes as certified by an independent testing laboratory.
  - 2. Pipe Joints: Plastic Cement Welding Solvents shall have a VOC content not to exceed 250 g/l.
- E. Structures: Standards specified and as indicated.
- F. Structure Castings: MDOT-SHA or Prince George's County Standards.
  - 1. Grates for storm drain inlets with grate tops shall be waffle shaped for wheel chair and bicycle safety. Slots shall not exceed 4" by 1 1/2".
- G. PVC Pipe for Infiltration Drywell: Schedule 40 Polyvinyl Chloride (PVC) sewer pipe as indicated and required by Prince George's County.
  - 1. Size: As indicated.

2. Perforations: Drill 1/4-inch perforations all around for entire length as indicated.
  3. Fittings: As indicated and required.
- H. Cleanouts:
1. Cleanout Ferrules and Plugs: Josam Series No. 58490 with cast iron body and bronze countersunk flanged plug. Size matching pipe size indicated. Contractor shall provide Owner with two "T" handles for recessed plugs.
  2. Cleanouts For Use in Paved Walk Areas: Josam Series No. 58360 adjustable floor cleanout with cast iron body and bronze plug and top. Size matching pipe size indicated. Contractor shall provide Owner with one cleanout wrench.
    - a. Expansion Joint: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.
  3. Fittings: Shall be as specified for PVC pipe (for pipe materials indicated).
- I. Filter Fabric: "Mirafi 140N" manufactured by Mirafi Incorporated, Charlotte, North Carolina. Contractor's Option: "Tygar", type 3341 manufactured by Remay Incorporated, Nashville, Tennessee, or approved equal.
1. Quality: Free of defects of flaws, which affect strength or filtering properties.
- J. Sand: ASTM C33 Fine Aggregate.
- K. Concrete: Refer to Section 33 10 00 "Utility Standards".
- L. Reinforcing Steel and Hardware: Refer to Section 33 10 00 "Utility Standards", and as noted:
1. Size and type of steel and hardware shall be as indicated.
  2. Exposed reinforcing steel shall be hot dip galvanized, ASTM A 767, Coating Class I.
  3. Hardware shall be hot dip galvanized, ASTM A 153.
- M. Miscellaneous Products:
1. Underground identification tape manufactured by Allen Systems, Houston, Texas. Tape shall be three inches wide, "Detectatape" type, "Safety Green" color, and marked "Caution Sewer Line Buried Below".

### PART 3 - EXECUTION:

#### 3.1 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:

- A. Refer to Section 33 10 00 "Utility Standards".

### 3.2 CONNECTIONS TO EXISTING SYSTEM:

- A. For structure construction over existing pipe, excavate and expose existing pipe at structure location indicated. Adjust structure location as directed by the Owner's Representative in the event existing pipe joint interferes with structure walls, at no increase to Contract Sum. Manually excavate below existing pipe prior to structure base placement. Place concrete base and construct structure as specified. Neatly cut and remove upper half of existing pipe and construct invert flow channel.
- B. For pipe connections to existing structures, excavate and expose existing structure. Cut and remove portion of existing structure wall required for pipe connection. Install pipe, through existing structure wall, flush with interior wall surface. Remove portion of existing invert flow channel required for connection and reconstruct as specified. Fill joint between pipe and existing structure wall with cement mortar.

### 3.3 PIPE:

- A. General: Install in accordance with manufacturer's installation instructions and as noted. Inspect each pipe laying length and pipe joint materials for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Begin installation at lowest system elevation and proceed up-grade. Field cut pipe only where required to complete structure-to-structure closures, install fittings or as specified. Cut pipe to smooth square end.
- B. Cast Iron Pipe: Install with spigot end of pipe pointing in direction of flow. Install fittings where indicated or required. Clean and lubricate joints, immediately prior to joining pipe, in accordance with manufacturer's recommendation. Position each laying length in previously installed pipe and push joint tightly together.
- C. Concrete Pipe: Install with tongue end of pipe pointing in direction of flow. Clean and thoroughly wet joints immediately prior to joining pipe. Apply thick liberal coat of mastic to groove and tongue. Position each laying length in previously installed pipe and pull joint tightly together with mechanical device designed for pipe jointing.
  - 1. Clean interior of each joint removing excess cement mortar and finish flush with surface. Fill exterior upper half of pipe joint with cement mortar.
- D. Polyvinyl Chloride (PVC) Pipe: Install pipe in accordance with ASTM D 2321,

manufacturer's installation instructions, and as noted.

1. Install with pipe spigot end pointing in flow direction. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed up-grade. Clean bell and spigot interior and exterior surfaces, removing oil, grit and foreign matter. Lubricate pipe ends and gasket in accordance with manufacturer's instructions. Position each laying length of previously installed pipe and manually push joint tightly together.
2. Field Pipe Cutting: Shape spigot end of cut pipe to resemble manufactured spigot end, with a pipe-beveling tool designed for PVC pipe. Copy the full insertion mark provided on the manufactured spigot end onto the prepared field cut end.

E. Corrugated Steel Pipe: Install in accordance with manufacturer's recommendations and instructions, and ASTM A 798.

F. High Density Polyethylene Pipe: Install in accordance with manufacturer's recommendations.

### 3.4 CLEANOUTS:

- A. Refer to Section 33 10 00 "Utility Standards" and as noted.
- B. Install cleanouts and construct concrete pads of Class "A" concrete as indicated.
- C. Cleanout in paved walk area shall be installed without a concrete pad. Top shall be cast into and set flush with finished walk surface.

### 3.5 STRUCTURES:

- A. Refer to Section 33 10 00 "Utility Standards" and as noted. Neatly cut pipes flush with interior structure walls. Construct invert flow channels smooth and semicircular in shape. Shape channels with horizontal circular curves, with radii as large as structure will permit or as indicated. Neatly form channels in structure base with bricks and cement mortar. Provide steps in structures exceeding 3.0 feet in depth. Vertical step spacing per standards specified.

### 3.6 BACKFILL:

- A. Refer to Section 33 10 00 "Utility Standards", and as noted.
- B. Polyvinyl Chloride (PVC) Pipe: Conduct backfill operations when pipe temperature is below 60 degrees Fahrenheit or during early morning hours to prevent excessive contraction.

- C. Underground Identification Tape: Install during backfill operations. Center tape horizontally over pipe, 12 inches above top of pipe.

3.7 WASTE MANAGEMENT:

- A. Recycle waste piping materials in accordance with Division 1 "Construction Waste Management" requirements.

END OF SECTION







